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of the

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MARCH, 1939

LISBON OIL FIELD, CLAIBORNE AND LINCOLN PARISHES, LOUISIANA[1]

V. P. GRAGE[2] AND E. F. WARREN, JR.[2]
Shreveport, Louisiana

ABSTRACT

The Lisbon oil field, in Claiborne and Lincoln parishes, Louisiana, was discovered in December, 1936. From present information, it appears that the localization of oil is controlled by the lenticular development of porosity in the Patton limestone which flanks the south edge of a broad structural nose. Production is obtained from the Patton limestone zone of lower Glen Rose age at an average depth of 5,200 feet. The effective porosity of the Lisbon producing zone is highly variable in thickness, varying from 4 feet to 22 feet, with an average of 12.6 feet. The daily field allowable is 10,000 barrels based on 3,252 developed acres as defined by the Louisiana Conservation Department. The field produced 2,405,000 barrels from 150 wells during 1937.

The original gas-oil ratios were very low, varying from 50 cubic feet to 300 cubic feet per barrel; consequently, no separators were used. With a rapid decline in bottom-hole pressures, the gas-oil ratios have shown a proportional increase. However, most wells have a ratio less than 2,000 cubic feet to the barrel at present. There are no established gas or water levels despite apparent interzone communication within the Patton limestone. It is the writers' opinion that the thickness and the areal extent of the "Oakes" limestone zone are the factors, independent of structure, which will control future developments of the Lisbon field.

INTRODUCTION

The Lisbon oil field, the discovery well of which was completed during December, 1936, is the fourth producing field developed in Claiborne Parish, Louisiana.

Compared with other fields of North Louisiana which are producing from the Trinity lower Glen Rose, the Lisbon oil field presents several unique features.

The present areal limits of the oil production apparently are controlled by lenticularity of the porous producing zone rather than by closed structure. Present well control does not indicate whether or not the Lisbon field is situated on the flank of a closed Lower Cretaceous

[1] Presented by title before the Association at New Orleans, March 18, 1938. Manuscript received, November 28, 1938.

[2] Gulf Refining Company.

structure. The highest well structurally is a dry hole and the lowest well structurally is a producing well. Present well control indicates that the Lisbon field is on a prominent structural nose in the Comanche Cretaceous.

The Lisbon field is the only one producing from the lower Glen Rose in North Louisiana in which the original gas-oil ratio was less than 500:1.

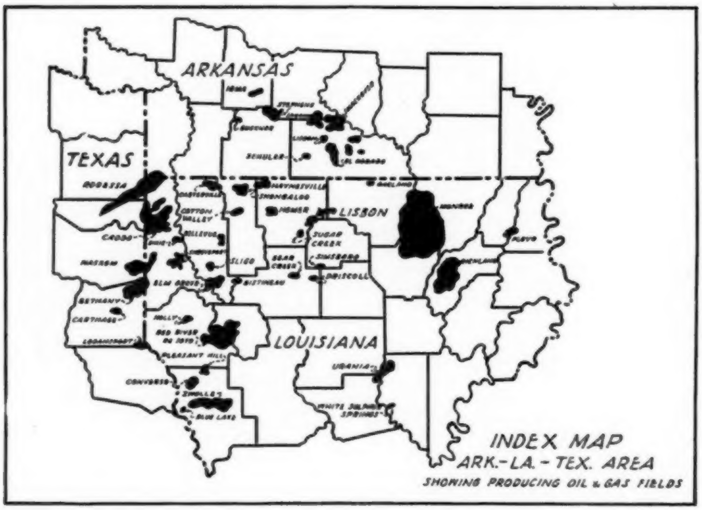


FIG. 1

Present wells have average ratios less than 2,000:1.

Geographically, the Lisbon field is some distance beyond the northeast limit of the North Louisiana Salt-Dome province, the limits of which are now approximately defined by the presence of penetration salt domes which have deformed the Tertiary formations. Regionally, the extent of the North Louisiana Salt-Dome province coincides approximately with a major regional downwarp defined by structural contours on the base of the Glen Rose Anhydrite zone.

The axis of this regional syncline trends approximately from south to north through Bienville and Webster parishes. Several major producing structures, for example, Cotton Valley, Bellevue, and Sligo, are west of this axis; major structures such as Homer and Sugar Creek are east of this axis. The Lisbon field is on the northeast flank of the North Louisiana syncline.

From a structural standpoint, the Lisbon and Sugar Creek fields are somewhat closely related, since both appear to be located on a northeast–southwest minor axis which plunges southwest into the North Louisiana syncline.

Location

The Lisbon oil field centers in the southeast corner of T. 21 N., R. 5 W., Claiborne Parish. Developed parts of the field lie within Claiborne and Lincoln parishes.

The village of Lisbon, from which the field takes its name, lies approximately 2 miles northeast of the center of the field.

The nearest producing fields are the Homer oil field, 13 miles due west, and the Sugar Creek oil and gas field, 6 miles southwest (Fig. 1).

Acknowledgments

The writers are indebted to the Gulf Refining Company of Louisiana for permission to publish this report, and for the use of the data contained in its files.

Especially are the writers indebted to W. P. Rand of the Gulf Research and Development Company for preparation of the cores illustrated in the report; to P. H. Jennings of the Magnolia Petroleum Company for many helpful suggestions and technical assistance in the photo-micrographic work; to C. L. Moody of the Ohio Oil Company for suggestions and criticisms; and to numerous members of the geological departments of various companies interested in the area, from whom the writers have secured many helpful suggestions, both in the editing and preparation of the report.

The writers wish to express their appreciation for the assistance and many helpful suggestions offered by Roy T. Hazzard of the Gulf Refining Company during the preparation of this paper.

History

During July, 1936, E. T. Oakes, independent operator of Homer, Louisiana, and associates, assembled a block of 3,000 acres in Claiborne and Lincoln parishes, which centered in Sec. 1, T. 20 N., R. 5 W.

Oil seepages around the surface casing of the United Gas Company's O. N. Meadows well No. 1 in Sec. 13, T. 21 N., R. 5 W., which was plugged and abandoned at a depth of 6,710 feet in August, 1933, directed the attention of these operators to the possibility of lower Glen Rose production in this general area.

The discovery well, Oakes *et al.* Patton No. 1 in the NE. ¼ of Sec. 1, T. 20 N., R. 5 W., was favorably situated with reference to the

highest closing contour of a well known subsurface structure contoured on the base of the Annona chalk. The center of the Lisbon field chalk structure is approximately 6 miles north of the Sugar Creek chalk structure, on the minor structural southwest-northeast axis, previously mentioned.

Acreage spreads were sold to various major companies and independent operators on a "bottom-hole" basis, by E. T. Oakes and associates, for financing the Patton well No. 1. The first well drilled under this contract was the H. W. Patton Estate No. 1, in the northeast corner of Sec. 1, T. 20 N., R. 5 W.; this well was junked and abandoned at a total depth of 4,244 feet. Operations began on May 26, 1935, and the well was abandoned, April 18, 1936.

The H. W. Patton Estate No. 2 was drilled 100 feet south and west of well No. 1 and was completed on December 24, 1936, at a total depth of 5,372 feet, logging 10 feet of saturated limestone in the lower part of the lower Glen Rose. On completion, the well gauged 147 barrels in the first 24 hours on a $\frac{1}{4}$-inch tubing choke.

Subsequent developments have not outlined the areal limits of the Lisbon field except on the north side.

Drainage and Topography

The Lisbon oil field is 12–15 miles east of the topographic divide between the Red River and the Ouachita River drainage systems. It lies between bayous D'Arbonne, on the south, and Middle Fork, on the north. These bayous are southeast-flowing components of the Ouachita River drainage system. Elevations in the Lisbon field range between 150 and 360 feet above sea-level. More than 200 feet of topographic relief exists.

Stratigraphy

SUBSURFACE FORMATIONS

COMANCHE CRETACEOUS

The Comanche Cretaceous is an important series of rocks from the standpoint of oil developments in North Louisiana as well as in South Arkansas and adjacent parts of East Texas.

The table of new geological names of the Arkansas-Louisiana-Texas area (Table I), which recently was approved and adopted by the Shreveport Geological Society, is presented here in order that the Comanche Cretaceous stratigraphy of the Lisbon field (Table II) may be more clearly discussed with reference to the regional stratigraphy.

Based on evidences offered by a study of samples from wells in the Lisbon field, it is fairly definitely indicated that the post-Trinity

Comanche, of Washita and Fredericksburg ages, and the Paluxy, uppermost Trinity, have been removed by pre-Upper Cretaceous erosion.

TABLE I

NEW GEOLOGIC NAMES
COMANCHE CRETACEOUS AND OLDER ROCKS
ARKANSAS-LOUISIANA-TEXAS AREA

Unconformity

COMANCHE SERIES			Washita and Fredericksburg—Undifferentiated
	TRINITY GROUP		*Paluxy formation.* Non-marine upper Trinity sands grading southward and southwestward into marine. (Oil-producing zones of Caddo district and De Soto-Red River field in upper part of Paluxy)
		GLEN ROSE SUB-GROUP	*Upper Glen Rose formation.* Marine limestones, shales, sandstones, and thin anhydrite stringers
			Glen Rose Anhydrite. Massive anhydrite
			Lower Glen Rose formation *Rodessa member.* Marine limestones, oölites, coquinas, shales, and thin anhydrite stringers. (Oil-producing zones of Rodessa in this member. Also Jeter zone of Sligo; gas at Logansport field and Kilpatrick gas zone of Sugar Creek field) *Pine Island member.* Dark-colored shale, some brown shale in lower part. Limestone at base locally. (Dixie and Dillon producing zones of Pine Island in this member; also Pettit zone of Sligo; Oakes zone of Lisbon field and the Darrett zone of Sugar Creek occur in this member; includes zone of transition into the underlying Travis Peak)
			Travis Peak formation. Non-marine red shales, siltstones, and mudstones. (Herndon sand of Pine Island; Holloway sand of Cotton Valley in top of Travis Peak. Darrett oil zone of Sugar Creek. Carter sand lens in top of Travis Peak and in basal part of Darrett zone. Basinward interfingers into a continuous marine section of dark shales and limestones)
PRE-COMANCHE (?)	PRE-TRINITY (?)		*Cotton Valley formation.* Black marine fossiliferous shale in northwest Louisiana. (Davis and Bodcaw deep sands of Cotton Valley field). *Schuler facies of Cotton Valley formation.* Non-marine red shales, mudstones, siltstones, and sandstones. Typically developed in the Schuler field, Union County, Arkansas (Morgan sands near top and Jones sand at base in Schuler field), and in the extreme northeastern part of Louisiana
			Buckner formation. Red and green shales, anhydrite, streaks dolomitic limestone and sandstones
			Smackover limestone. Buff limestone with Reynolds oölitic member at top. (Gas and distillate at Snow Hill; oil at Buckner; gas and oil at Schuler. Probably represented in North Louisiana by black shales and black shaly limestones)
			Eagle Mills formation. Red shales and mudstones. Anhydrite and salt in South Arkansas are considered equivalent in age

The pre-Trinity (?) (pre-Comanche?) formations, as listed in Table I, undoubtedly underlie the Lisbon field. Whether or not it will be possible to recognize these formations as distinct lithologic

units comparable in character with the typical sections found in deep wells in South Arkansas, will be dependent on the outcome of future deep drilling in the Lisbon field.

TABLE II

COMANCHE CRETACEOUS
LISBON FIELD
CLAIBORNE AND LINCOLN PARISHES, LOUISIANA

<table>
<tr><td rowspan="6">COMANCHE SERIES</td><td rowspan="6">TRINITY GROUP</td><td rowspan="5">GLEN ROSE SUB-GROUP</td><td colspan="2">Upper Glen Rose formation
(red-bed and sandstone facies in upper part)</td></tr>
<tr><td colspan="2">Glen Rose Anhydrite</td></tr>
<tr><td colspan="2">Lower Glen Rose formation</td></tr>
<tr><td rowspan="2"></td><td>Rodessa member
(red-bed and sandstone facies in upper part)</td></tr>
<tr><td>Pine Island member</td></tr>
<tr><td colspan="3">Travis Peak formation</td></tr>
</table>

The Trinity group in the Lisbon field has a total estimated thickness of approximately 4,100 feet. As previously mentioned, the upper part of the Trinity in the Lisbon field has been removed by pre-

TABLE III

COMPARISON OF THICKNESSES OF FORMATIONS OF TRINITY GROUP

	Lisbon Field Claiborne and Lincoln Parishes Louisiana Composite Section	*Rodessa Field Caddo Parish Louisiana Composite Section*	*Gulf Refining Company's Hatcher No. 1 Sec. 11, T. 17 N., R. 15 W. Caddo Parish, Louisiana*
Paluxy	Not present	1,300	1,200
Upper Glen Rose	430 average (Eroded in part)	610	750
Glen Rose Anhydrite	200	250	260
Lower Glen Rose	1,180	1,050	1,220
Travis Peak	2,250 est.	1,700±	2,245
Total	4,060	4,910±	5,675

Upper Cretaceous erosion. Table III shows the thicknesses of the Trinity formations for the Lisbon field, as compared with the Rodessa field and with a deep well in west-central Caddo Parish.

TRINITY GROUP

TRAVIS PEAK

The oldest beds which have been penetrated in the Lisbon field are Travis Peak in age. The Lisbon Oil Company's Burgess well No. 1 in Sec. 3, T. 20 N., R. 5 W., is reported to have penetrated the upper 400 feet of the Travis Peak.

The thickness of the Travis Peak underlying the Lisbon field is estimated to be approximately 2,250 feet. This estimate is based on the Travis Peak encountered in United Gas-Brownfield well No. 2 located in Sec. 5, T. 19 N., R. 5 W., Claiborne Parish, in the Sugar Creek field.

The Travis Peak formation, as the term is used in this paper, is a group of predominantly non-marine sediments, intervening between the lower Glen Rose formation and the Cotton Valley formation.

The upper limit of the Travis Peak formation is defined as the contact between the fossiliferous, argillaceous limestones and fossiliferous black shales of the lower Glen Rose formation and the underlying fine-grained non-calcareous or slightly calcareous clastics of red, greenish, or gray color.

In the fields of the Arkansas-Louisiana-Texas area where sufficient deep wells have been drilled, it is indicated that the lower Glen Rose-Travis Peak contact is sufficiently distinct for marking a time boundary between two periods of contrasted conditions of sedimentation. However, from a regional standpoint, this time boundary does not appear to be a persistent one throughout any wide area. It appears that the contrasted sedimentary environments which define the character of the lower Glen Rose-Travis Peak contact in a local area have migrated toward the edges of the sedimentary basin and upward in the stratigraphic column.

It is the writers' opinion that the sedimentation between beds of Travis Peak age and beds of lower Glen Rose age was continuous in the Arkansas-Louisiana-Texas area.

The lower Glen Rose-Travis Peak contact in the Lisbon field occurs approximately 60 feet below the top of the Patton producing zone. It is sharply defined by the change from calcareous sediments to red, greenish and gray, micaceous, fine sandy shales or mudstones.

Deep wells in the Sugar Creek field show that the Travis Peak as a unit is made up of red, brown, and greenish gray clays and mudstones and fine-grained gray and red sandstones. A marine wedge made up of fossiliferous, black shale and dark-colored, shaly limestones has been encountered in the upper part of the Travis Peak

formation of the Sugar Creek field. It is possible that this marine wedge may occur within the Travis Peak underlying the Lisbon field.

Dependent on the information furnished by the two deep wells in the Sugar Creek field, and deep wells in the Cotton Valley field, the base of the Travis Peak formation is defined as the contact between an overlying series of interbedded red and grayish green shales and fine-grained quartzitic sandstones and an underlying series of interbedded black calcareous, fossiliferous and black non-calcareous, fissile shales and thin-bedded, fine-grained, calcareous sandstones.

In northwest Louisiana, the Travis Peak-Cotton Valley contact appears to be a conformable contact separating an overlying shallow-water marine deltaic deposit from an underlying shallow-water series of fossiliferous, dark, calcareous fine-grained sediments. These latter sediments are characterized by a greater amount of disseminated carbonaceous material and lignitized plant fragments than are the overlying sediments of the basal Travis Peak.

The contact of the Travis Peak and Cotton Valley formations in North Louisiana is sharply defined in the electrical surveys of deep wells drilled in Sugar Creek and Cotton Valley.

GLEN ROSE SUB-GROUP

LOWER GLEN ROSE FORMATION

The lower Glen Rose formation of the Lisbon field is a marine formation made up in large part of fossiliferous limestones and calcareous shales with some reddish brown shales and gray, fine-grained sandstones in the upper part.

The upper limit of the lower Glen Rose formation is placed at the base of the overlying massive anhydrite. Its lower limit is the top of the Travis Peak.

The average thickness of the lower Glen Rose in the Lisbon field is 1,175 feet. On the basis of lithology, the lower Glen Rose formation in North Louisiana is divided into two members: an upper member, the Rodessa member; and a lower member, the Pine Island member.

Table IV gives average thicknesses and lithologic character of the sedimentary units making up the lower Glen Rose formation of the Lisbon field.

Three lithologic units of the lower Glen Rose are of particular interest due to their distinct lithologic characters. Two of these, the lower Anhydrite stringer and the James zone, have sufficiently widespread development in North Louisiana and South Arkansas to serve as easily recognizable subsurface datum horizons. The third unit, the

Patton zone, is of special economic importance in the Lisbon field, as it is the only commercial oil-producing zone developed to date.

TABLE IV

AVERAGE THICKNESS AND LITHOLOGIC CHARACTER OF LOWER GLEN ROSE UNITS IN LISBON FIELD

		Lithological Character	*Average Thickness in Feet*
LOWER GLEN ROSE	*Rodessa Member* (630–680 feet in thickness)	Slightly porous, oölitic and fossiliferous gray limestones and thin interbedded dark shales—oil and gas showings. (This zone produces gas in the Sugar Creek (Kilpatrick zone) and Cotton Valley field)	35
		Dark-colored, calcareous shale	50
		Anhydrite (first stringer below massive) with interbedded shales	35
		Reddish brown and gray sandy shales and fine-grained sandstones	120–170
		Dark calcareous shales and thin-bedded limestones	65
		Porous, sandy limestones	90
		Dark-colored, calcareous shales and thin-bedded, gray, fossiliferous limestones	165
		Porous, sandy, oölitic coquina-type limestone ("James zone")	70
	Pine Island Member (495–545 feet in thickness)	Dark-colored, fossiliferous, calcareous shales	270
		Porous limestones	20
		Dark-colored shales	40
		Argillaceous, fossiliferous limestone and interbedded shales ("Three-Fingered limestone")	45
		Dark-colored, calcareous shales	50
		Argillaceous, porous, oölitic fossiliferous, sandy limestone ("Patton zone"—oil)	0–20
		Argillaceous limestones, oölitic in part, dark shales with local development of fine-grained, lignitic, salt water-bearing sandstone	70–100
		Total	1,125 to 1,225, Average 1,175

ANHYDRITE STRINGER

The interval from the base of the lower Anhydrite stringer to the base of the overlying massive anhydrite is approximately 120 feet in

the Lisbon field. The base of the stringer serves as an additional datum horizon.

"JAMES ZONE"

Electrical logs of deep wells drilled in north-central Louisiana show the existence of a porous limestone in the lower Glen Rose which has sufficient constancy of character and areal distribution to be used as a datum horizon.

The lithologic character of this limestone zone was first described from cores taken between depths of 3,820 and 3,915 feet in the Arkansas Fuel Oil Company's James well No. 1 in Sec. 14, T. 20 N., R. 1 E., Union Parish. The name "James zone" has been given to this zone of porous, oölitic, sandy, fossiliferous, coquina-type limestone.

In the Lisbon field, the "James zone" comprises an average thickness of 70 feet of porous, oölitic, sandy, fossiliferous, conquina-type limestone. The base of the "James zone" defines the base of the Rodessa member of the lower Glen Rose formation.

Correlation of electrical logs and drillers' logs shows that the "James zone" of north-central Louisiana and adjacent parts of South Arkansas is equivalent to the oil- and gas-producing "Dees and Young zones" of the Rodessa field.

PATTON ZONE

The reservoir rock of the Lisbon field, a porous limestone of variable thickness, lithologic character, and areal distribution, has been named the Patton zone after the lease on which the discovery well was drilled.

Drilling to date in the Lisbon field and in adjacent areas indicates that the Patton zone, a minor stratigraphic unit, is a porous limestone lentil developed in the basal part of the Pine Island member of the lower Glen Rose.

The Patton zone appears to be equivalent stratigraphically to some part of the uppermost Pettit zone of the Sligo field. The porous Patton zone is not developed in the near-by Sugar Creek field.

The Patton producing zone of the Lisbon field is made up of porous limestones and dense, shaly limestones interbedded with thin, discontinuous streaks of shale. The porous limestones are extremely variable in character. The predominant type is a coarse-textured oölitic, coquina type of limestone which has varying admixtures of fine-grained sand and calcareous mud. Brecciated shell fragments give an appearance of extreme coarseness of texture to some of the porous limestones. Fine-grained porous oölitic limestones which have a "mealy" texture are also found. Well preserved fossils are uncommon. A few well pre-

served corals have been noted in several cores. These corals have not been identified. Plates I–IV illustrate the variations in the textural detail of cores of the porous limestone of the Patton zone.

The Patton zone may be defined as a neritic limestone deposit, formed in relatively shallow waters, which is overlain and underlain by calcareous shales interbedded with thin argillaceous limestones. The porous limestones of the Patton zone apparently grade laterally into dark calcareous shales or mudstones. The Patton limestone lentil is definitely elongate northeast and southwest. Conditions contributing to its formation apparently bear no relationship to the present structural configuration of the area as contoured on the base of the Glen Rose anhydrite.

The variable composition, thickness and areal distribution of the porous limestone of the Patton zone and its immediate association with dense, argillaceous limestones and dark-colored, fossiliferous, calcareous shales are indicative of the sedimentary conditions under which the Patton zone was deposited.

The coarse textural character of the porous limestones of the Patton zone is dependent in large part on the brecciated shell fragments making up much of the rock. It appears that this fragmentation must have been related to wave action in the littoral or near-littoral zone, though not necessarily in the locality where the coarse-textured limestones are now found.

It is the writers' opinion that the shell débris, oölites, and sandy admixtures making up the coarse to fine-textured limestones of the Patton zone were laid down as a veneer upon a mud bottom, by intermittent longshore current transportation. The cross-section profile of the Patton zone is not particularly indicative of a submarine bar profile, although it is, of course, possible that incipient bar formation by wave action in the shallow muddy seas may have contributed to the formation of the porous Patton lentil. Concentrations of shell débris with associated oölites and fine sandy admixtures in a mud environment are difficult to explain unless these materials are viewed as transported from outside sources.

Localization of oil in the porous limestones of the Patton lentil points to the inference that the oil actually may have originated in these porous limestones. Whatever may be the factors which eventually contribute to the origin of oil, it is generally agreed that marine organic material which has been preserved in the sediments is a primary prerequisite. The viewpoint that the Patton lentil is a current-spread veneer on a muddy sea bottom, which veneer was rich in organic material at time of deposition, favors the inference that

the oil may have originated in the porous lentil. This viewpoint demands that the veneer of shell débris and its contained organic material be quickly buried by muds. Such rapid burial of the sediments which comprise the Patton lentil, whether in an area characterized by the presence of large colonies of benthonic marine scavengers or in an area relatively free from these scavengers, would

TABLE V

THICKNESS AND LITHOLOGIC CHARACTER OF GLEN ROSE ANHYDRITE AND UPPER GLEN ROSE

	Lithologic Character	*Average Thickness in Feet*
Upper Glen Rose	Red sandy shales and fine-grained sands grading downward into black, calcareous shales with thin-bedded, fossiliferous limestones. Variation in thickness due to erosional truncation with greater thickness on south side of field	180–415
	Interbedded black shales and thin limestones with 3 thin anhydrite stringers 5–15 feet in thickness. Anhydrite stringers are lenticular and are not everywhere developed	65
	Fossiliferous, black, calcareous shales with thin, interbedded limestones	140
		Total 385 to 620
Glen Rose anhydrite	Milky to grayish anhydrite with interbedded streaks of black, calcareous shale. Estimated that anhydrite makes up 85 per cent of section	200

Average interval, first anhydrite stringer to top of Massive anhydrite	205
Average interval, base of Massive anhydrite to base of lower stringer	120

tend to preserve whatever original organic material was present in the sediments as they were being laid down.

In the case of an incipient submarine bar being formed on a muddy bottom, continuous wave action would have tended to retard the rapidity of burial and would have allowed easy access to the marine organic material of the mud by the bottom-living scavengers, assuming, of course, that they were present in sufficiently large numbers to have been a major factor in robbing the sediments of their inferred high original organic content.

Associated with the Patton lentil, both below and above, are calcareous muds, which may or may not have been fairly rich in organic material. These muds may have contained the necessary organic material to give origin to the oil now found in the Patton zone. The accumulation of the oil in the porous limestones of the Patton zone may have taken place subsequent to its formation in

TABLE VI

STRATIGRAPHIC SEQUENCE OF GULF CRETACEOUS, LISBON FIELD

Group	*Formation*	*Average Thickness in Feet*	*Character and Lithology*
---	-------	-----	*Unconformity* ---------------
NAVARRO	Arkadelphia	100±	Dark calcareous, fossiliferous shales, chalky shales, and thin streaks of hard, gray, argillaceous chalk and gritty chalk
	Nacatoch	175±	95 feet± interbedded hard, sandy fossiliferous limestones and medium-coarse-grained soft sands and sandy shales
			80 feet± dark calcareous fossiliferous shales and thin streaks chalky shale
TAYLOR	Saratoga	240	30 feet± hard, gray, slightly porous chalk with thin streaks of hard, calcareous shale
	Marlbrook		160 feet± interbedded dark, calcareous fossiliferous shales and chalky shales
	Annona		50 feet± hard, gray, medium-porous fossiliferous chalk and interbedded dark gray, fossiliferous chalky shales
	Ozan	320	30 feet± porous, grayish white, medium-coarse-grained, glauconitic sands and interbedded fossiliferous sandy shales
			200 feet± dark-colored, calcareous, fossiliferous shales; sandy shales and thin streaks hard calcareous sands
			90 feet± soft, porous, grayish white, medium to coarse-grained glauconitic sands; thin streaks hard, fossiliferous, sandy limestone and dark-colored sandy shale
	Brownstown	175	Dark-colored, fossiliferous shales, sandy shales, thin-bedded limestones and sandstones
AUSTIN	Tokio	315	100 feet± medium coarse, grayish white sands containing volcanic ash and thin streaks of gray sandy shale
			215 feet± grayish white sandy shales and thin interbedded sands and calcareous sands
EAGLE FORD ?	Bingen (restricted)	125	Red clays and shales; reddish gray sandy shales; and bentonitic tuffaceous sands; medium to coarse-grained chloritic, biotitic sands
---	-------	-----	*Unconformity* ---------------

Total average thickness 1,450±

the underlying muds. Upward migration, into the overlying porous reservoir, brought about by compaction would account for its present localization.

GLEN ROSE ANHYDRITE AND UPPER GLEN ROSE

The Glen Rose anhydrite has an average thickness of 200 feet in the Lisbon field. Table V gives the thicknesses and lithologic characteristics of the Glen Rose anhydrite and upper Glen Rose.

The red-bed facies of the upper Glen Rose formations lies unconformably below the Bingen formation (restricted) of Gulf Cretaceous age. This red-bed facies of the upper Glen Rose is made up of red and gray, micaceous, sideritic shales and sandy shales and thin lenticular fine-grained sandstones. It grades downward into black shales and thin limestones of the typical marine lithologic character of the upper Glen Rose.

In the Lisbon field the red-bed facies of the upper Glen Rose is separable from the overlying red volcanic Bingen formation on the basis of lithology; the red beds of the upper Glen Rose are not characterized by bentonite or chlorite.

Subsurface Formations

GULF CRETACEOUS

In the Arkansas-Louisiana-Texas area, both the upper and the lower limits of the Gulf Cretaceous are defined by unconformable contacts.

In the Lisbon field, the uppermost member of the Gulf Cretaceous, the Arkadelphia, is overlain unconformably by the Midway of Eocene age; and the lower limit is the base of the Bingen (restricted) formation, which here rests unconformably on red beds of the Trinity upper Glen Rose.

Lithologically, the Gulf Cretaceous of the Lisbon area is made up of chalks, limestones, shales, sands, and tuffaceous red and gray sands and shales.

The detailed stratigraphic sequence of the Gulf Cretaceous in the Lisbon field is shown in Table VI.

With the exception of one formation unit, the Gulf Cretaceous of the Arkansas-Louisiana-Texas area has been described in detail in publications by other writers.[3] The Gulf Cretaceous sequence found

[3] A. C. Veatch, "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas," *U. S. Geol. Survey Prof. Paper 46* (1906).
Carle H. Dane, "Upper Cretaceous Formations of Southwestern Arkansas," *Arkansas Geol. Survey Bull. 1* (1929).
L. P. Teas, "Irma Oil Field, Nevada County, Arkansas, *Structure of Typical American Oil Fields*, Vol. I (Amer. Assoc. Petrol. Geol., 1929).

in the Lisbon field is essentially the same as described in these publications, to which reference may be made for comparison of these fields with the Lisbon field.

BINGEN FORMATION (RESTRICTED)

The term Bingen formation (restricted), as applied to Lisbon field, is descriptive of a subsurface lithological unit made up in large part of reddish brown, tuffaceous and bentonitic sandy clays and grayish white, tuffaceous, chloritic and biotitic sandstones, which, throughout North Louisiana and South Arkansas, rests unconformably on the truncated Comanche Cretaceous. In the Arkansas-Louisiana-Texas area this formation is overlain by the predominantly gray, coarse-grained, tuffaceous sands and sandy shales of the Tokio formation of Austin age.

In the Lisbon field, the Bingen (restricted) rests unconformably on the red-bed facies of the upper Glen Rose formation. There is insufficient subsurface information in the area of the Lisbon field to determine whether or not the Tokio-Bingen contact is conformable.

The Bingen formation (restricted), as this formation is previously defined, is a widespread lithologic unit of fairly constant character throughout North Louisiana and South Arkansas. Hazzard[4] has applied the name Bingen to this widespread waterlaid volcanic section and has demonstrated that the Bingen of the subsurface intergrades downdip into fossiliferous Eagle Ford, and updip into the volcanic Woodbine of southwest Arkansas.

The Bingen formation (restricted) has a thickness of approximately 125 feet in the Lisbon field.

TOKIO FORMATION

In the Lisbon field, a thickness of 315 feet of sands and sandy shales is assigned to the Tokio formation of Austin age.

W. C. Spooner, "Stephens Oil Field, Columbia and Ouachita Counties, Arkansas," *ibid.*, Vol. II (1929).
———, "Homer Oil Field, Claiborne Parish, Louisiana," *ibid.*
———, "Oil and Gas Geology of the Gulf Coastal Plain in Arkansas," *Arkansas Geol. Survey Bull. 2* (1935).
L. P. Teas, "Bellevue Oil Field, Bossier Parish, Louisiana," *Structure of Typical American Oil Fields*, Vol. II (Amer. Assoc. Petrol. Geol., 1929).
C. D. Fletcher, "Structure of the Caddo Field, Caddo Parish, Louisiana," *ibid.*

[4] Roy T. Hazzard, "The Bingen Formation of the Arkansas-Louisiana-Texas Area (paper in preparation).
A. C. Veatch, *op. cit.*
C. S. Ross, H. D. Miser, and L. W. Stephenson, "Water-Laid Volcanic Rocks of Early Upper Cretaceous Age in Southwestern Arkansas, Southeastern Oklahoma, and Northeastern Texas," *U. S. Geol. Survey Prof. Paper 154-F* (1929).

BROWNSTOWN FORMATION

The Brownstown formation is made up predominantly of calcareous gray and brownish shales, with thin-bedded sandstones and limestone shells. It has an average thickness of 175 feet in the Lisbon field.

OZAN FORMATION

The Ozan formation of the Lisbon field is made up of slightly glauconitic, sandy, gray, micaceous, brown and black, calcareous shales and medium- to coarse-grained sands, with a total thickness of 320 feet. Chalky shales and thin streaks of calcareous shale occur at the top. The lower 90 feet of this section is greenish gray, glauconitic, medium- to coarse-grained sand which is the stratigraphic equivalent of the Buckrange sand of South Arkansas. The Buckrange has been a prolific oil-producing zone in several of the fields of the Arkansas-Louisiana-Texas area; in the Lisbon field it contains salt water. The Ozan formation is apparently conformable with the underlying Brownstown and with the overlying Annona chalk.

ANNONA CHALK

The Annona chalk is made up of approximately 50 feet of hard, white and gray, slightly porous chalk with subordinate beds of chalky shale. It is limited at the top by the Marlbrook and at the base by the Ozan formation.

The contrasted lithologic characteristics of the hard, white chalk of the basal Annona and the underlying sandy shales of the Ozan are easily recognizable both from well cuttings and in electrical logs.

MARLBROOK FORMATION

The calcareous shales and marls intervening between the Saratoga chalk above and the Annona chalk below, are assigned to the Marlbrook formation. This formation has an average thickness of 160 feet in the Lisbon field.

SARATOGA CHALK

The Saratoga chalk is made up of hard, white, slightly porous chalk with thin intercalated beds of chalky shale. Its average thickness is 30 feet. This formation, because of its distinct lithologic character compared with the overlying Nacatoch and the underlying Marlbrook, is easily recognized from well cuttings and in electrical logs.

NACATOCH FORMATION

The top of the Nacatoch formation in the Lisbon field is defined as the top of the first calcareous porous sand encountered below the top of the Gulf Cretaceous.

The Nacatoch formation is divisible into two distinct lithologic units, an upper sandy and calcareous member and a lower shaly member.

The upper 95-foot unit consists of interbedded hard porous, sandy, fossiliferous limestones and medium- to coarse-grained, soft porous sands, which grade downward through porous sands into shaly sands and sandy shales. The lower 80-foot unit of the formation consists of dark-colored, calcareous, fossiliferous shales interbedded with thin streaks of chalky shale.

The Nacatoch sand, a major oil- and gas-producing zone of North Louisiana and South Arkansas, makes up the upper member of the Nacatoch formation. No oil or gas showings have been reported in the Nacatoch sand of the Lisbon field.

ARKADELPHIA FORMATION

The Arkadelphia formation is made up primarily of fossiliferous chalky shales and subordinate amounts of chalk. It has an average thickness of 100 feet in the Lisbon field. Its lower limit is defined as the top of the Nacatoch formation.

In the Lisbon field, the contact between the chalky shales of the Arkadelphia and the overlying chalky shales of the Eocene Midway, in many places is difficult to recognize from the lithologic character as recorded in drillers' logs and in electrical logs. However, this contact, where it actually occurs in a cored section, may be recognized on a basis of comparative lithology. A marked faunal break is recognized by micropaleontologists at the Midway-Arkadelphia contact. Regionally the Midway-Arkadelphia contact marks a widespread unconformity.

Subsurface Formations

TERTIARY

No formations younger than the Tertiary Eocene are found in the subsurface of the Lisbon field. For a matter of convenience, in Table VII, the Tertiary formations of the Lisbon field and adjacent areas include the Cockfield and Cook Mountain formations of the Claiborne group, which are present at the surface.

TABLE VII

TERTIARY FORMATIONS OF LISBON FIELD AND ADJACENT AREAS

Age	*Group*	*Formation*	*Average Thickness in Feet*
Eocene	Claiborne	Cockfield	Not present in field proper
		Cook Mountain	275
		Sparta	550
		Cane River	170
	Wilcox	Undifferentiated	630
	Midway	Undifferentiated	435

MIDWAY FORMATION

The Midway formation is the oldest Eocene formation found in the subsurface of the Lisbon field. It rests unconformably on the Arkadelphia formation of Gulf Cretaceous age, and is overlain conformably by the Wilcox formation.

The Midway has an average thickness of 435 feet. The upper 385 feet consists of dark gray to black, non-calcareous shales characterized by siderite concretions ranging throughout this entire thickness. The lower 50 feet is made up of fossiliferous calcareous shales.

The micro-assemblage[5] of the lower 50 feet of calcareous shale indicates that there is represented therein the Kincaid formation[6] which rests unconformably on the Gulf Cretaceous and the overlying Mexia member of the Wills Point formation.[7] Throughout northwest Louisiana and represented in the Lisbon field, there is a grayish white, fossiliferous, bentonitic zone within the calcareous shales.

WILCOX FORMATION

The Wilcox formation is made up of brown, chocolate, and gray clays, sandy clays, and cross-bedded lignitic sands with claystone boulders throughout. It has an average thickness of 630 feet in the Lisbon field. No marine, fossiliferous sediments have been recognized in this section. The Wilcox grades downward through a sandy transition zone into the typical dark-colored, bedded shales of the Midway. Exact contact of the Wilcox and Midway is difficult to recognize in

[5] C. I. Alexander, personal communication.

[6] "The Geology of Texas," *Univ. Texas Bull. 3232*, Vol. I, Pt. 2 (1932).

[7] *Ibid.*

drillers' logs, although there is a fairly distinct lithological change at this contact based on a study of samples.

The base of the Cane River formation, basal member of the Claiborne group, defines the upper limit of the Wilcox.

CANE RIVER FORMATION

The Cane River formation of the Lisbon field, basal member of the Claiborne group, is made up of gray and brown, glauconitic, fossiliferous sandy clays, glauconitic sands, and lignitic sands. The top and base are marked either by beds of sideritic claystone boulders or fossiliferous calcareous clays.

The definite marine characteristics of the Cane River formation as compared with the non-marine lignitic sands and clays of the overlying Sparta and the underlying Wilcox, serve to readily distinguish this lithologic unit.

The Cane River formation has an average thickness of 170 feet in the Lisbon field. It has not been divided, on the basis of lithology, into distinct members which might be correlated with the Weches, Queen City, and Reklaw formations of the East Texas embayment.

SPARTA FORMATION

The Sparta formation in the Lisbon field is made up, in large part, of unconsolidated lignitic, grayish white sands with subordinate strata of micaceous, lignitic, dark gray to brown clays. It has an average thickness of 550 feet. It rests conformably on the Cane River and is overlain conformably by the Cook Mountain.

Sands of the Sparta formation furnish fresh water for drilling operations in the Lisbon field.

Surface Formations

TERTIARY

Reddish weathering sands and sandy clays interbedded with numerous indurated, discontinuous ironstone ledges, of the uppermost Cook Mountain, make up the surface outcrops of the area embracing the Lisbon field. Fossil casts are found here and there in the ironstone beds.

Two hundred and seventy-five feet is the maximum thickness of the Cook Mountain in the Lisbon field as determined from study of well samples.

In the areas adjacent to the Lisbon field, outcrops of grayish weathering sandy clays and unconsolidated sands, existing as hilltop remnants, are considered to be Cockfield, uppermost Claiborne, in age.

Structure

SURFACE

The discontinuous contact pattern of the Cockfield-Cook Mountain contact, through Claiborne, Bienville, and Lincoln parishes, is suggestive that the subsurface structure of the Gulf Cretaceous in the Sugar Creek-Lisbon area as a unit, is reflected, to lesser amount, by the areal distribution of the surface formations through these parishes.

The area embracing the Lisbon field, which is surfaced with beds of Cook Mountain age, is partly encircled, on the west, north, and east, by discontinuous patches of Cockfield, the average elevations of which are less than the surface elevations of the Cook Mountain in the Lisbon field. This feature is also true of the Sugar Creek field, with encircling Cockfield, on the east, south, and west, of the central part of this field.

As previously pointed out in the introduction, the Lisbon and Sugar Creek structures taken as a unit, make up an elongate northeast-southwest regional structure in the subsurface of the Gulf Cretaceous rocks. The surface structure of this area confirms, to a lesser degree, the existence of the structure in the subsurface.

SUBSURFACE

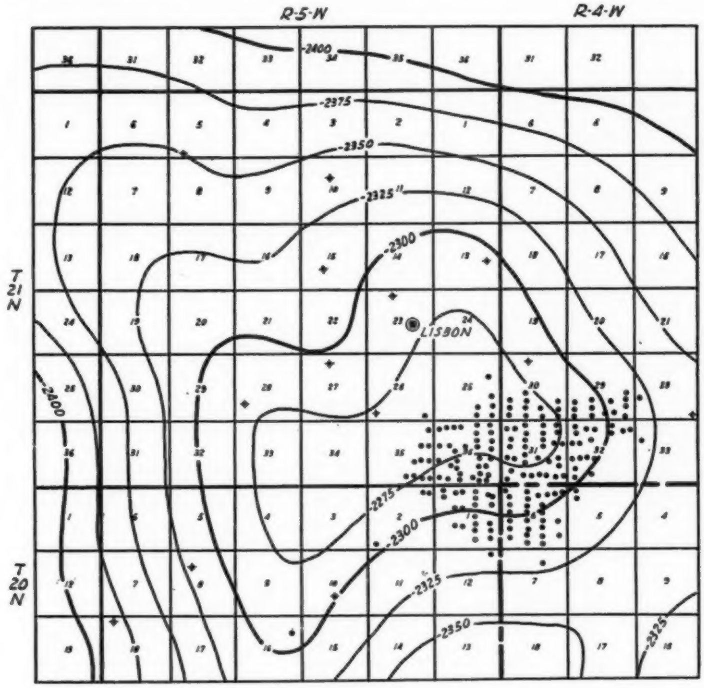
Figure 2 illustrates the structure of the Lisbon field, contoured on the base of the Annona chalk, with 25-foot contour intervals.

The Lisbon chalk structure is domal in shape with a slight elongation from southwest to northeast. It has an estimated maximum closure of 50 feet with lowest closing subsea contour of minus 2,325 feet. Rate of dip, on the flanks of the chalk structure, varies from 25 to 40 feet to the mile. The present concentrated well pattern in the area immediately adjacent to the discovery well in Sec. 1, T. 20 N., R. 5 W., is determined by the developed limits of the porosity in the producing zone.

The deep well drilled during 1933 in Sec. 13, T. 21 N., R. 5 W., the United Gas Company's Meadows well No. 1 with total depth of 6,710 feet, failed to find porosity in the Patton zone. On the basis of the chalk structure, as defined by later developments, this well was favorably located. Future extensions of the Lisbon field probably will be dependent on limits of porosity of the Patton zone with no direct relationship to chalk structure.

The Comanche Cretaceous structure of the Lisbon field is mapped on two contour horizons: the base of the Massive anhydrite (Fig. 3), and the top of the Patton producing zone (Fig. 4). The structural

pictures as interpreted on these two datum horizons are very similar in pattern. These maps were confined to deep-well control within the present developed parts of the field and are not indicative of the regional structural relief.



STRUCTURAL CONTOUR MAP
Lisbon oil field
Claiborne & Lincoln Parishes, La.

Datum—base annona chalk
Contour interval 25 feet

FIG. 2

There is insufficient deep-well control at this time in the areas north, northeast, and northwest of the Lisbon field to indicate whether or not there exists a closed structure on the base of the Massive anhydrite north of the present limit of production.

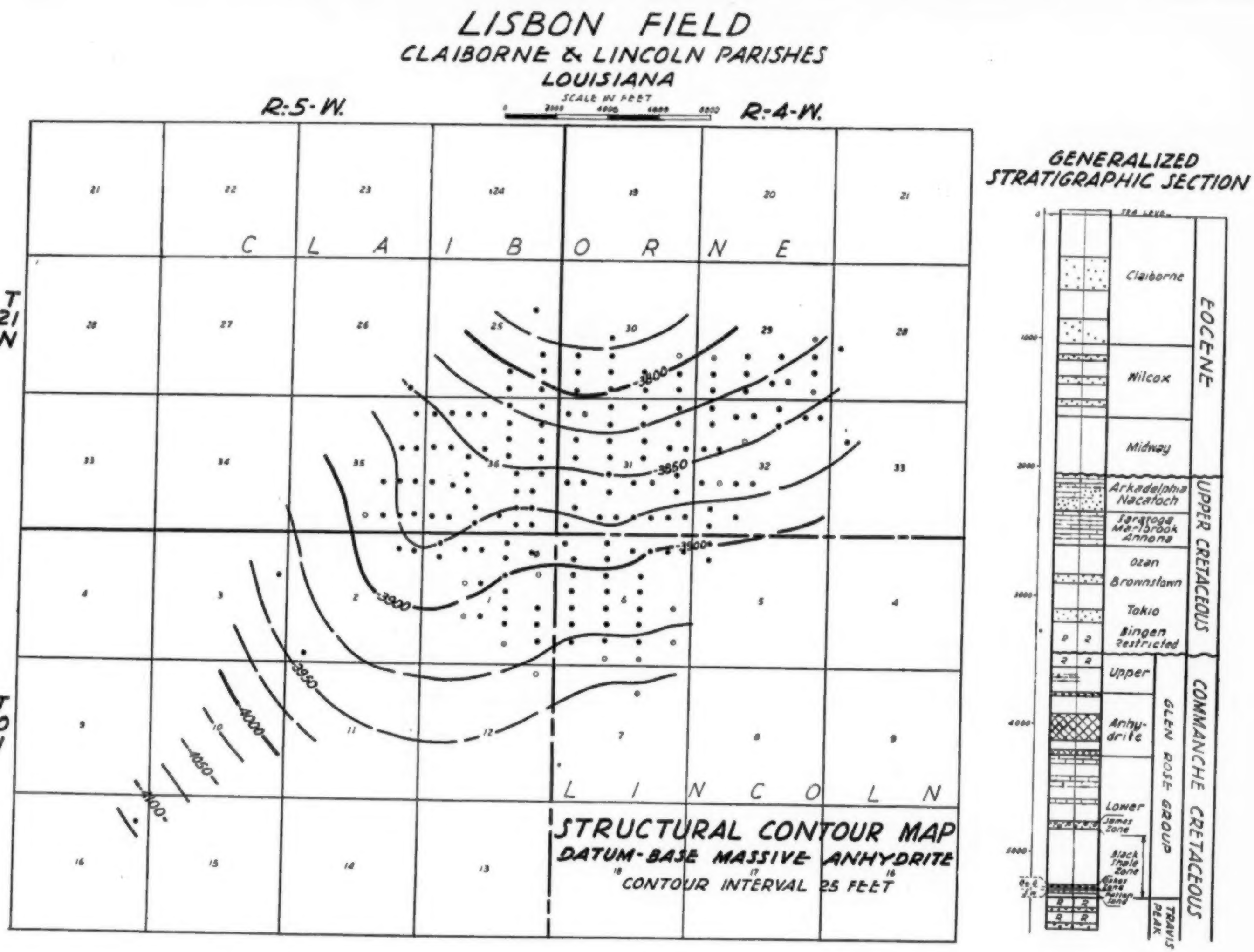

LISBON FIELD
CLAIBORNE & LINCOLN PARISHES
LOUISIANA
SCALE IN FEET
R:5-W.
R:4-W.
T 21 N
T 20 N
CLAIBORNE
LINCOLN
STRUCTURAL CONTOUR MAP
DATUM-BASE MASSIVE ANHYDRITE
CONTOUR INTERVAL 25 FEET
GENERALIZED STRATIGRAPHIC SECTION
EOCENE
Claiborne
Wilcox
Midway
UPPER CRETACEOUS
Arkadelphia Nacatoch
Saratoga Marlbrook Annona
Ozan
Brownstown
Tokio
Bingen Restricted
COMMANCHE CRETACEOUS
GLEN ROSE GROUP
Upper
Anhydrite
Lower
James Zone
Black Shale Zone
TRAVIS PEAK

Fig. 3

FIG. 3

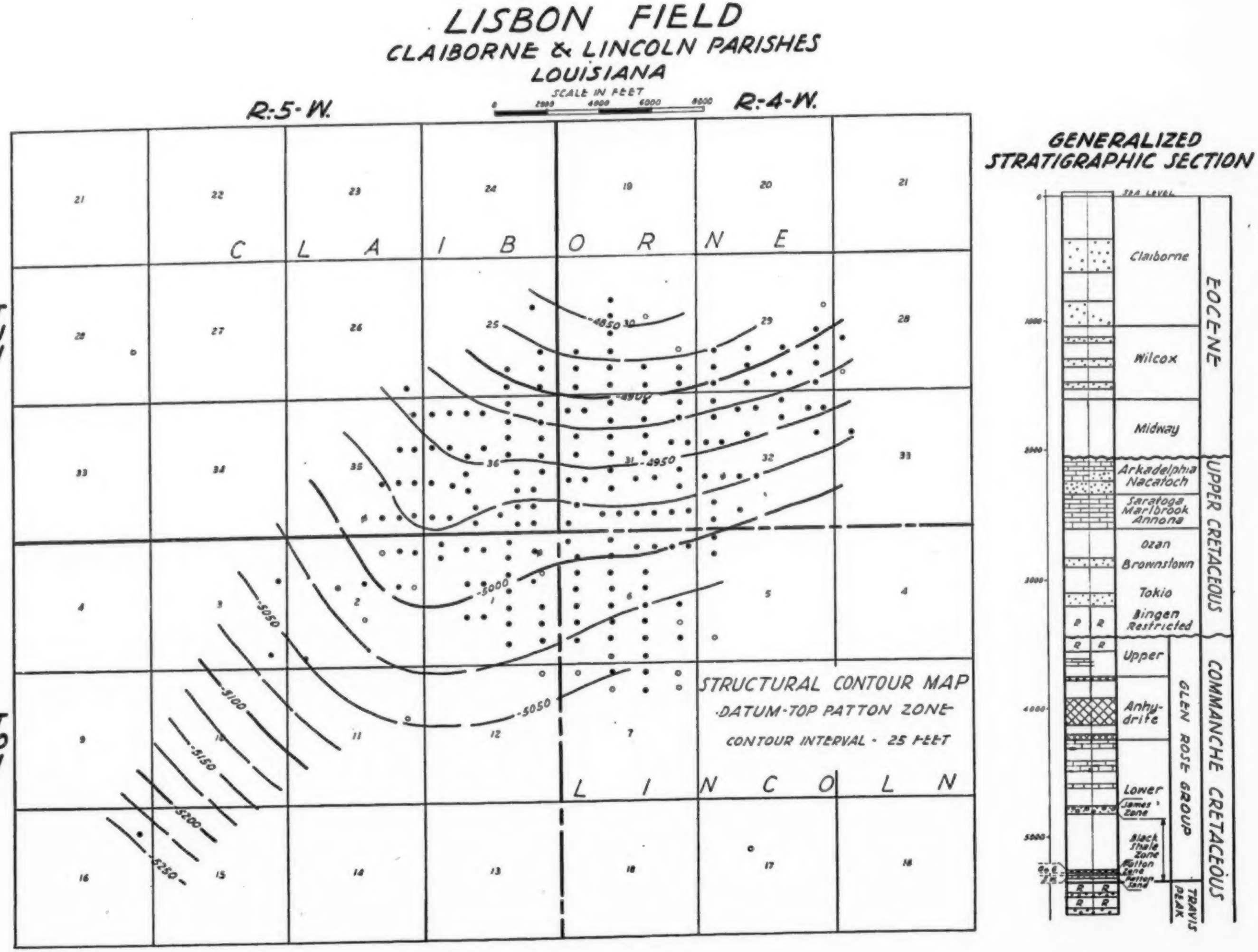

LISBON FIELD
CLAIBORNE & LINCOLN PARISHES
LOUISIANA
SCALE IN FEET
R:5-W.
R:4-W.
T 21 N
T 20 N
CLAIBORNE
LINCOLN
STRUCTURAL CONTOUR MAP
DATUM-TOP PATTON ZONE
CONTOUR INTERVAL - 25 FEET
-4850
-4900
-4950
-5000
-5050
-5100
-5150
-5200
-5250
GENERALIZED STRATIGRAPHIC SECTION
SEA LEVEL
EOCENE
Claiborne
Wilcox
Midway
UPPER CRETACEOUS
Arkadelphia
Nacatoch
Saratoga
Marlbrook
Annona
Ozan
Brownstown
Tokio
Bingen
Restricted
COMMANCHE CRETACEOUS
GLEN ROSE GROUP
Upper
Anhydrite
Lower
James Zone
Black Shale Zone
Patton Zone
Patton Sand
TRAVIS PEAK

FIG. 4

Present subsurface information shows that the structure of the Lisbon field in the Comanche Cretaceous is a southwest-plunging nose, open toward the northeast, with major structural axis aligned N. 30° E. A regional structural picture indicates that a saddle intervenes between the southerly developed part of the Lisbon field and the domal structure of the Sugar Creek field.

There is a slight increase in the rate of southerly dip on the top of the Patton zone over the rate of dip on the base of the Massive anhydrite, which divergence is due to thickening southward of the interval between the base of the Massive anhydrite and the top of the Patton zone.

As will be emphasized later, the Comanche Cretaceous structure of the Lisbon field does not appear to be the controlling factor in the localization of the oil accumulation in the porous limestones of the Patton zone.

PATTON PRODUCING ZONE

The top of the Patton oil zone of the Lisbon field occurs at an average depth of 425 feet below the top of the Pine Island member, and at a depth ranging from 1,055 to 1,105 feet below the base of the Massive anhydrite, with the greater interval toward the southwest.

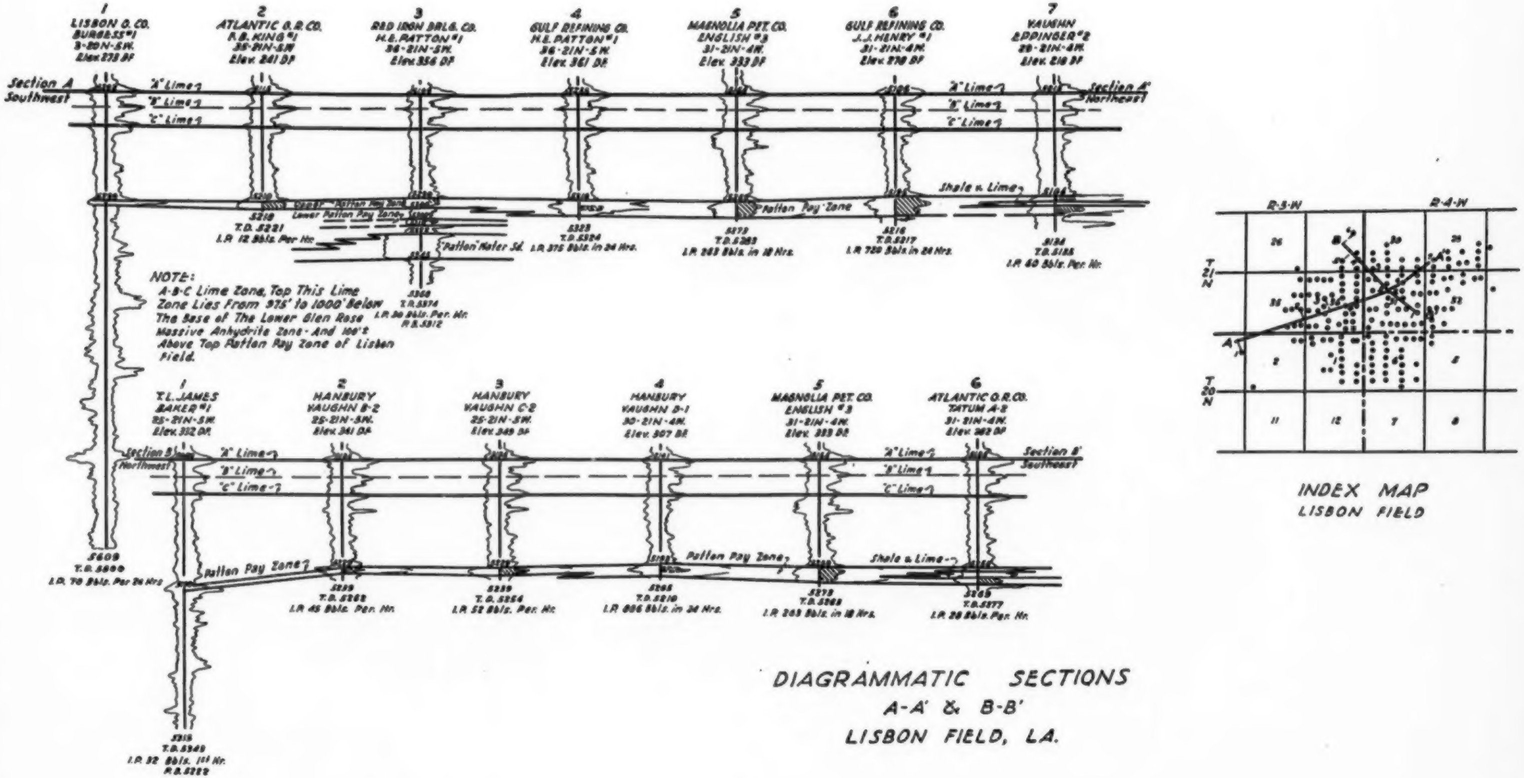
The porous parts in the Patton zone are made up primarily of oölitic and coquina-type limestones. These limestones are variable in composition as well as in porosity (Pls. 1–4). The lithologic character of the porous limestones of the Patton zone grades rapidly from fine-grained, sandy, oölitic, coquina-type limestones to dense oölitic limestones. These rapid changes in lithologic character are not limited to lateral variations, but also are marked vertically.

Two diagrammatic cross sections made from electrical logs are shown in Figure 5. Section *AA′* is drawn from southwest to northeast; and *BB′* from northwest to southeast across the Lisbon field. The lenticularity of the effective porosity of the Patton zone is illustrated in both sections.

The writers' views on the origin of the porous limestones of the Patton zone already have been discussed in some detail under the heading of Stratigraphy of the lower Glen Rose.

The writers' opinion is that the limestone porosity of the Patton zone is a primary feature originating at the time of deposition. However, it may have been due in part to solution of matrix and shell aggregate closely following deposition.

No conclusive observational facts derived from study of actual cores can be cited in proof of the viewpoint that the porosities of the Patton limestones are primary in character.



Section A Southwest
Section A' Northeast
"A" Lime
"B" Lime
"C" Lime
Shale & Lime
Patton Pay Zone
NOTE:
A-B-C Lime Zone, Top This Lime Zone Lies From 975' to 1000' Below The Base of The Lower Glen Rose Massive Anhydrite Zone - And 100'± Above Top Patton Pay Zone of Lisbon Field.
Section B Northwest
Section B' Southeast
INDEX MAP
LISBON FIELD
DIAGRAMMATIC SECTIONS
A-A' & B-B'
LISBON FIELD, LA.

FIG. 5

EXPLANATIONS OF PLATES

Magnification of 12 diameters. All cores cut perpendicular to normal bedding plane. All photo-micrographs were made with rock slices immersed in water.

PLATE I

FIGURE 1

R. L. Bauman—C. S. L. Patton No. 1
Location—Cen. of N. ½ of SW. ¼ NE. ¼ Sec. 1, 20 N., 5 W.
Core 5340–45 (lower part of Patton "pay")
Illustrating association of megascopic shell fragments with various-sized oölites in finely crystalline calcite matrix.

FIGURE 2

R. L. Bauman—C. S. L. Patton No. 1
Core 5340–45
Illustrating darker, dull, granular calcite patches (center of field) with younger, lighter-colored, finely crystalline calcite matrix; and various-sized oölites.

FIGURE 3

R. L. Bauman—C. S. L. Patton No. 1
Core 5340–45
Illustrating pore space (dark-colored) in clear finely crystalline calcite matrix; and loss of pore space within individual oölites (lower half of field) through later calcite deposition.

FIGURE 4

Harry Hanbury—Vaughn No. D-2
Location—Cen. of N. ½ of SW. ¼ SW. ¼ Sec. 30, 21 N., 4 W.
Core 5170–71
Illustrating an open channel (dark elongate area in center of field) with lining of secondary calcite deposited along edges.

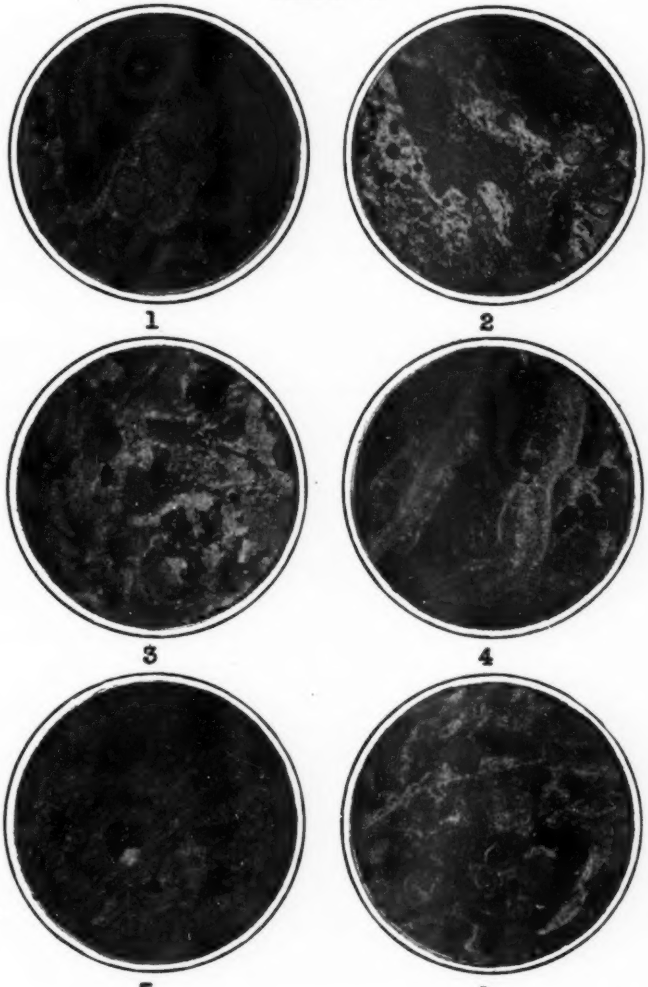
FIGURE 5

E. W. Gill—S. M. English No. 1
Location—Cen. of S. ½ of NE. ¼ SW. ¼ Sec. 29, 21 N., 4 W.
Core 5122–27 (upper part)
Illustrating the development of irregular laminae of calcareous shale present in a fine-grained oölitic limestone.

FIGURE 6

Gulf Refining Company—S. E. Tatum No. 1
Location—Cen. of N. ½ of SW. ¼ SW. ¼ Sec. 32, 21 N., 4 W.
Core 5279–88
Illustrating enlarged pore space developed (dark area, lower right) in finely crystalline rock matrix with associated irregularly shaped limestone fragments, which are made up of several individual oölites.

PLATE I



1 2

3 4

5 6

PLATE 2

FIGURES 1 and 2

R. L. Bauman—C. S. L. Patton No. 2
Location—Cen. of S. ½ of SW. ¼ NE. ¼ Sec. 1, 20 N., 5 W.
Core 5358–66
Illustrating the well developed concentric growth rings of individual oölites (center of field) with uniform distribution of pore space (dark areas) in finely crystalline calcite matrix.

FIGURE 3

Harry Hanbury—Vaughn No. C-2
Location—Cen. of N. ½ of SE. ¼ SE. ¼ Sec. 25, 21 N., 5 W.
Core 5139–40
Illustrating an aggregate of various-sized oölites in a limestone matrix of dull granular texture (lower right) and clear, finely porous, cryptocrystalline calcite (left side of field).

FIGURE 4

Harry Hanbury—Vaughn No. C-2
Core same as above
Illustrating development of finely crystalline calcite along sutures of megascopic fossil cast.

FIGURE 5

Magnolia Petrol. Co.—S. M. English No. 1
Location—Cen. of S. ½ of SE. ¼ NW. ¼ Sec. 31, 21 N., 4 W.
Core 5282–84
Illustrating large pore spaces (dark areas) developed within fine-grained sandy oölitic matrix.

FIGURE 6

Magnolia Petrol. Co.—S. M. English No. 1
Core 5284–86
Cen. of S. ½ of SE. ¼ NW. ¼ Sec. 31, 21 N., 4 W.
Illustrating a uniform distribution of smaller-sized oölites and associated pore spaces (small dark areas) in a fine-grained sandy, clear, finely crystalline matrix.

PLATE II

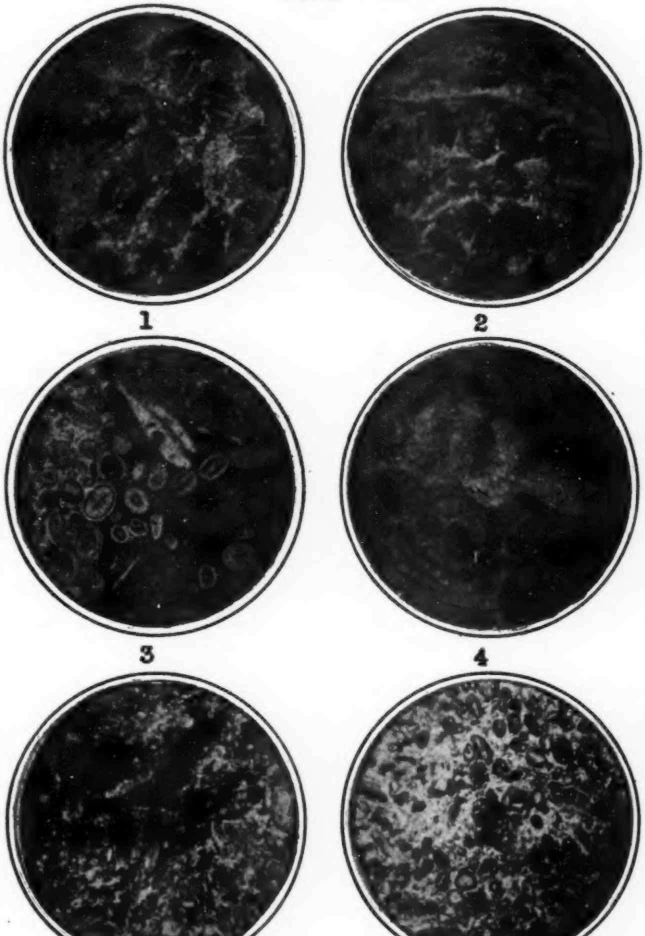


PLATE 3

FIGURES 1 and 2

Lyons and Neely—H. E. Patton No. B-2
Location—Cen. S. ½ of NE. ¼ SW. ¼ Sec. 6, 20 N., 4 W.
Core 5306–07 (upper part of "pay")
Illustrating variability in texture of limestone matrix due to a later period of calcite deposition. In Figure 1 (upper center of field) secondary porosity developed in oval oölite has been completely lost through a later deposition of clear, finely crystalline calcite.

FIGURE 3

Lyons and Neely—H. E. Patton No. B-2
Core 5306–07
Illustrating a loss of primary (?) porosity due to a later deposition of finely crystalline calcite (left-hand side).

FIGURE 4

Lyons and Neely—H. E. Patton No. B-2
Core 5306–07
Illustrating small pore spaces (dark areas) in finely crystalline limestone matrix with associated various-sized oölites.

FIGURE 5

Lyons and Neely—H. E. Patton No. B-1
Location—Cen. of N. ½ of NE. ¼ SW. ¼ Sec. 6, 20 N., 4 W.
Core 5345–46
Illustrating the association of large pore spaces (dark areas) in matrix of fine, sandy, oölitic limestone and a later period of finely crystalline calcite deposition (light areas).

FIGURE 6

Lyons and Neely—H. E. Patton No. B-2
Location—Cen. of S. ½ of NE. ¼ SW. ¼ Sec. 6, 20 N., 4 W.
Core 5306–07
Illustrating a tight, fine-grained, crystalline limestone matrix of low porosity with one large pore space (dark area in upper center).

PLATE III

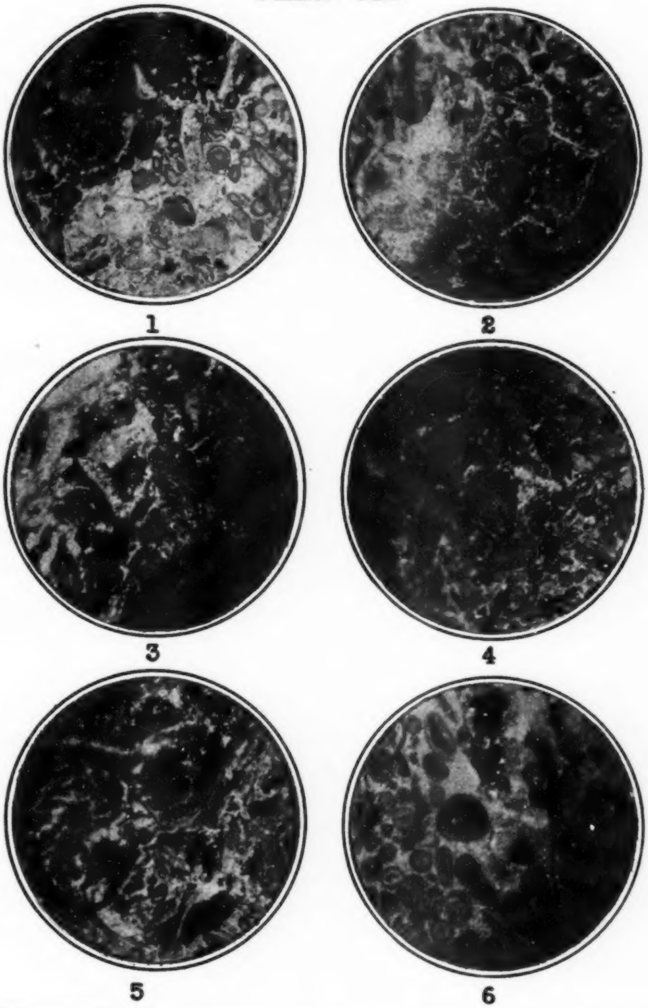


PLATE 4

FIGURE 1

Olson Drilling Company—H. W. Patton Est. No. 1
Location—Cen. of S. ½ of SE. ¼ SE. ¼ Sec. 26, 21 N., 5 W.
Core 5263½–66
Illustrating a fine-grained sandy, crystalline calcite matrix with numerous uniform-sized pore spaces distributed throughout rock slice.

FIGURE 2

Olson Drilling Company—H. W. Patton Est. No. 1
Core 5263½–66
Illustrating the concentric structure of isolated oölites in a finely crystalline, finely porous calcite matrix; with irregular distribution of relatively large pore spaces (dark areas).

FIGURES 3 and 4

Sloan and Zook—Patton Est. No. 4
Location—Cen. of S. ½ of NW. ¼ NW. ¼ Sec. 1, 20 N., 5 W.
Core 5264½–74
Illustrating character of fine-grained, well sorted lignitic sand of the Patton salt-water sand below the Patton "pay."

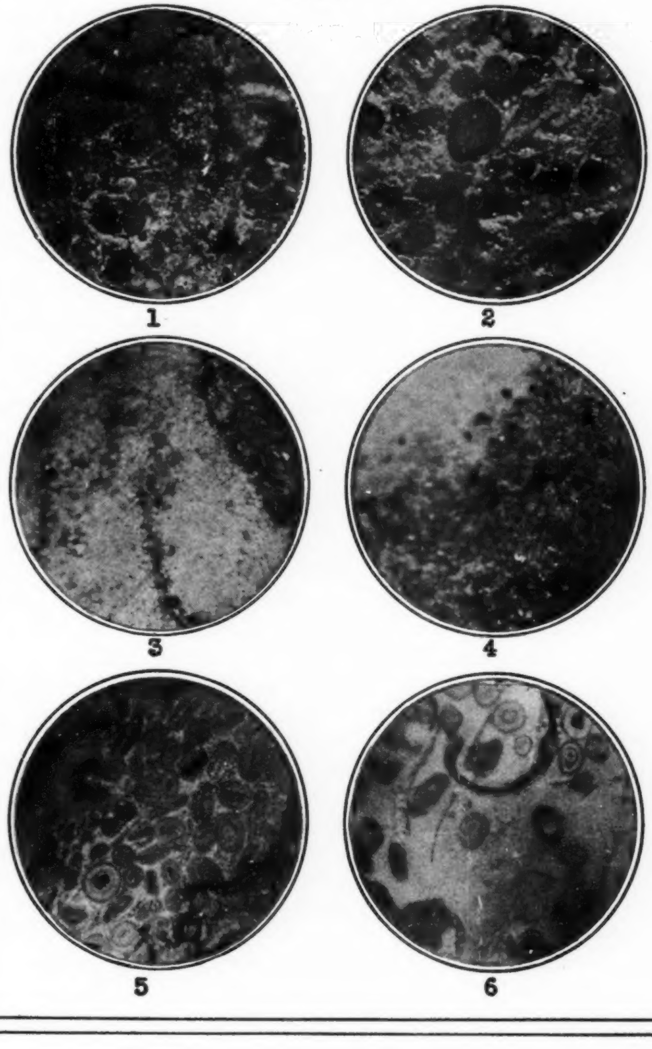
FIGURE 5

Lyons and Neely—H. W. Patton Est. No. 2
Location—Cen. of S. ½ SW. ¼ NW. ¼ Sec. 6, 20 N., 4 W.
Core 5315–16
Illustrating irregular laminae of calcareous mud (dark lines in lower right-hand corner of field) associated with a dense, uniformly oölitic limestone of low porosity.

FIGURE 6

Sloan and Zook—Patton Est. No. 4
Location—Cen. of S. ½ of NW. ¼ NW. ¼ Sec. 1, 20 N., 5 W.
Core 5249–54
Illustrating small coral fragment (dark fan-shaped object in lower left field) and curved cross section of a large shell (in upper center), with the association of isolated oölites in a light-colored dull granular limestone matrix of low porosity.

PLATE IV



These Patton limestones, however, are similar in lithologic character to present-day shell or coquina-type limestones forming or recently formed near sea-level, in which the fragmentary débris is knitted together with insufficient cementing matrix, forming a porous aggregate.

In support of the viewpoint that the Patton limestones have original porosity, there may be cited the evidence that the lower Glen Rose of this area is characterized by continuous zones of porous, oölitic and coquina-type limestones. These limestones are of wide areal extent and in many places have a thickness as great as 50 feet. It seems difficult to visualize conditions under which a secondary and selective solution of original and tightly cemented limestones of such widespread extent and thickness could be operative to produce porous limestones.

Microscopic examination of rock slices prepared from a representative group of cores of the porous limestones of the Patton zone shows the existence of two distinct types of calcite in the matrix: (1) cementing material of a darker dull granular type of calcite which occupies, in part, the original interstices between shell fragments and oölites, which latter components make up the greater part of the rock; this cementing material undoubtedly was laid down with the coarse oölite and shell aggregate; and (2) cementing material of a finely crystalline variety, of a later generation of calcite which appears both in the darker matrix and in the solution cavities within individual oölites and within shell fragments.

The development of solution cavities and minute channels both in the matrix and within individual oölites, and of larger cavities within shell fragments, points to a period of limited solution within the rock subsequent to its consolidation. The secondary deposition of finely crystalline calcite following this period of solution, was insufficient to destroy the porosity considered to be originally present in the rock at the time of its consolidation.

The aggregate thickness of porous limestones in the Patton zone of the Lisbon field varies from $2\frac{1}{2}$ feet in the Lisbon Oil Company's Burgess well No. 1 in Sec. 3, T. 20 N., R. 5 W., to 20 feet plus in Love Brothers' J. J. Henry well No. 1 in Sec. 31, T. 21 N., R. 4 W. (Fig. 6). The average thickness for the present developed limits of the field is 12.6 feet.

The variation in thickness of the producing zone is indicated in Figure 6. A study of this map, in conjunction with the detailed structural maps, indicates that there is no direct relationship between detailed structure and the areal distribution of porosity.

The lateral extent of porosity in the Patton zone appears at present to be limited, at least on two sides of the Lisbon field, west and north, respectively.

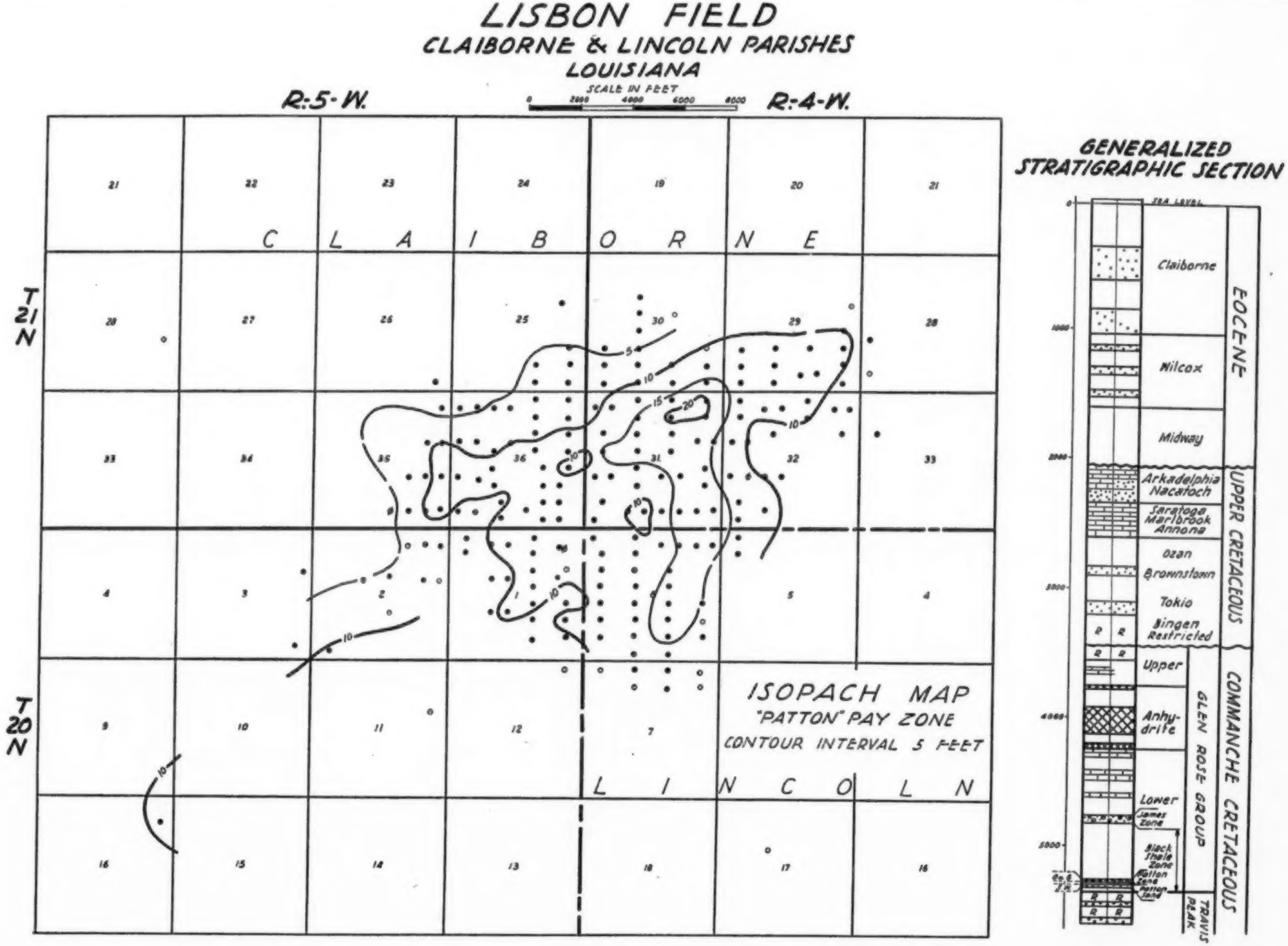

LISBON FIELD
CLAIBORNE & LINCOLN PARISHES
LOUISIANA
SCALE IN FEET
R:5-W.
R:4-W.
T 21 N
T 20 N
C L A I B O R N E
L I N C O L N
ISOPACH MAP
"PATTON" PAY ZONE
CONTOUR INTERVAL 5 FEET
GENERALIZED STRATIGRAPHIC SECTION
SEA LEVEL
EOCENE
Claiborne
Wilcox
Midway
UPPER CRETACEOUS
Arkadelphia
Nacatoch
Saratoga
Marlbrook
Annona
Ozan
Brownstown
Tokio
Bingen
Restricted
COMMANCHE CRETACEOUS
GLEN ROSE GROUP
Upper
Anhydrite
Lower
James Zone
Black Shale Zone
Patton Zone
TRAVIS PEAK

FIG. 6

TABLE VIII

CORE ANALYSIS, PATTON PRODUCING ZONE, LISBON FIELD, COMPILED FROM 48 CORES FROM 21 PRODUCING WELLS

Company	Well	No.	Location	Depths	Permeability-(Millidarcys) Hori-zontal	Verti-cal	Po-rosity	Satu-ration	Oil Content by Volume	Salt Content
Atlantic O. & R. Company	F. B. King	1	E½ NE¼ SE¼ 35-21-5	5211-5213	38	42	17.2	----	----	---
" " " " "	" " "	1	E½ NE¼ SE¼ 35-21-5	5213-5215	1	1	13.1	----	----	---
" " " " "	" " "	1	E½ NE¼ SE¼ 35-21-5	5215-5217	0	0	7.9	----	----	---
" " " " "	" " "	1	E½ NE¼ SE¼ 35-21-5	5217-5219½	16	1	15.1	----	----	---
" " " " "	" " "	1	E½ NE¼ SE¼ 35-21-5	5219½-5220½	2	1	11.3	----	----	---
De Armon & McMillen	H. E. Patton	1	E½ SW¼ NW¼ 36-21-5	5235-5237	6	59	20.7	----	----	---
" " " "	" " "	1	E½ SW¼ NW¼ 36-21-5	5237-5239	91	151	26.9	----	----	---
" " " "	" " "	1	E½ SW¼ NW¼ 36-21-5	5239-5240	13	8	15.6	----	----	---
" " " "	" " "	1	E½ SW¼ NW¼ 36-21-5	5240-5241	25	16	22.6	----	----	---
" " " "	" " "	1	E½ SW¼ NW¼ 36-21-5	5241-5242	8	56	17.5	----	----	---
" " " "	" " "	1	E½ SW¼ NW¼ 36-21-5	5242-5243	30	2	17.7	----	----	---
Gulf Refining Company	H. E. Patton	1	NEc NW¼ SE¼ 36-21-5	5316	---	---	31.9	16.0	5.1	Nil
" " "	" " "	2	SEc NW¼ SE¼ 36-21-5	5311-5324	---	---	15.2	7.8	4.3	Nil
" " "	" " "	2	SEc NW¼ SE¼ 36-21-5	5328-5331	---	---	10.76	15.0	1.62	Nil
" " "	Eva Bennett	1	SWc SW¼ SW¼ 31-21-4	5295-5303	---	---	21.2	21.9	4.6	Nil
" " "	S. E. Tatum	1	N½ SW¼ SW¼ 32-21-4	5288	---	---	12.0	9.4	1.1	---
" " "	M. Patton	1	N½ NW¼ SE¼ 6-20-4	5266	---	---	12.5	36.7	4.9	---
T. L. James & Company	H. W. Patton	2	SWc NE¼ SE¼ 36-21-5	5323-5325	79	---	22.0	----	----	---
" " " " "	" " "	2	SWc NE¼ SE¼ 36-21-5	5325-5328	1	---	9.8	----	----	---
" " " " "	" " "	2	SWc NE¼ SE¼ 36-21-5	5328-5332	3	7	15.6	----	----	---
" " " " "	" " "	2	SWc NE¼ SE¼ 36-21-5	5334-5336	65	19	24.3	----	----	---
Love Petroleum Company	H. E. Patton	1	SEc SE¼ SW¼ 36-21-5	5331-5343	0	21	13.2	----	----	---
Lyons & Neely	Aycock	1	S½ NW¼ SW¼ 6-20-4	5361-5370	---	---	32.7	12.2	4.0	---
" " "	"	1	S½ NW¼ SW¼ 6-20-4	5370-5380	---	---	20.0	5.2	1.0	---
" " "	H. E. Patton	B-1	N½ NE¼ SW¼ 6-20-4	5345	---	---	20.0	16.89	3.37	---
" " "	" " "	B-2	S½ NE¼ SW¼ 6-20-4	5309-5311	---	---	14.9	18.9	2.9	---
Magnolia Petroleum Company	S. M. English	1	S½ SE¼ NW¼ 31-21-4	5282-5288 Top	---	---	32.0	15.7	5.0	Nil
" " "	" " "	1	S½ SE¼ NW¼ 31-21-4	5282-5288 Bot.	---	---	33.4	17.0	3.6	Nil
" " "	" " "	1	S½ SE¼ NW¼ 31-21-4	5289-5292	---	---	6.1	Sl. Trace	0	Nil
" " "	" " "	1	S½ SE¼ NW¼ 31-21-4	5292-5297	---	---	22.9	20.3	4.7	Nil
E. T. Oakes (Discovery Well)	Patton	2	NE¼ NE¼ 1-20-5	?	---	---	23.2	7.0	0	Nil
Oden & Evans	H. W. Patton	1	SWc SE¼ SE¼ 36-21-5	5346	---	---	23.2	17.9	4.1	Nil
Olson Drilling Company	T. W. Patton	1	S½ NW¼ SW¼ 30-21-4	5158-5164 Bot.	---	---	24.4	20.5	5.1	Nil
Red Iron Drilling Company (P. W. Woodruff)	Patton	1	S½ SW¼ NE¼ 36-21-5	5292	---	---	22.3	24.1	5.4	Nil
"	"	1	S½ SW¼ NE¼ 36-21-5	5294	---	---	22.4	20.5	4.6	Nil
"	"	2	N½ SW¼ NE¼ 36-21-5	5288-5290	0	0	10.1	----	----	---
"	"	2	N½ SW¼ NE¼ 36-21-5	5290-5292	15	8	16.7	----	----	---
"	"	2	N½ SW¼ NE¼ 36-21-5	5292-5294	124	---	22.0	----	----	---
"	"	2	N½ SW¼ NE¼ 36-21-5	5294-5296	0	1	10.1	----	----	---
Shreveport Oil Corporation	Edmonds	1	SEc NE¼ NE¼ 16-21-5	4280-4285	---	---	20.5	----	----	---
" " "	"	1	SEc NE¼ NE¼ 16-21-5	5398-5413	---	---	13.4	16.3	2.1	---
Schuster et al	Sallie Lloyd	1	S½ SW¼ SW¼ 2-20-5	5257-5271 Mid.	---	---	25.0	85.0	21.6	---
" " "	" "	1	S½ SW¼ SW¼ 2-20-5	5257-5271 Bot.	---	---	23.7	20.4	4.8	---
J. C. Tippett et al	H. E. Patton	1	SWc SE¼ NW¼ 36-21-5	----	0	0	7.8	----	----	---
" " " " "	" " "	1	SWc SE¼ NW¼ 36-21-5	----	Split	12	23.5	----	----	---
" " " " "	" " "	1	SWc SE¼ NW¼ 36-21-5	----	14	21	20.9	----	----	---
" " " " "	" " "	1	SWc SE¼ NW¼ 36-21-5	----	19	19	20.8	----	----	---
" " " " "	" " "	1	SWc SE¼ NW¼ 36-21-5	----	4	---	16.8	----	----	---

Table VIII shows permeabilities, percentages of oil saturation, porosities, and oil and salt content of cores from various wells in the Lisbon field.

Data compiled by various companies operating in the Lisbon field have been freely drawn upon by the writers in compiling this tabulation.

POROSITY AND SATURATION

Porosities of cores from the Patton zone vary from 7.8 to 33.4 per cent; saturation from 7 to 24 per cent. Porosity and saturation percentages exhibit rapid changes both vertically and horizontally. Due to the limited number of cores analyzed, the data probably are not representative of the field as a whole.

PERMEABILITY

As indicated in Table VIII, the range in vertical permeabilities is from 0 to 151 millidarcys; range in horizontal permeabilities is from 0 to 124 millidarcys.

Due to the wide range in permeabilities, both vertically and horizontally, and the limited data available, it is doubtful whether or not any definite conclusions as to the future behavior of the Patton reservoir should be drawn from the attached permeability data.

It is inferred that the effectiveness of the low horizontal permeabilities of the porous limestones of the Patton zone is reflected in present well behavior of certain flowing wells which have difficulty in maintaining allowables. The few pumping wells have difficulty in maintaining a constant fluid level, under a 24-hour pumping schedule, which factor also points toward a restricted fluid movement to the face of the bore hole.

SALT WATER

To date, there are no producing wells in the Lisbon field which are showing an appreciable amount of salt water from the Patton zone.

Developments in the Lisbon field have not determined the presence of salt water within the Patton zone downdip from producing wells. Nine wells in the south-central part of the field have drilled into a fine-grained, lignitic, cross-bedded water sand, the top of which is approximately 30 feet below the top of the Patton zone. This sand is known locally among operators as the Patton salt-water sand, after the farm name of the first well which encountered salt water in this zone. This salt-water sand apparently lenses out toward the north; it was not present in the T. L. James-Baker well No. 1 in Sec. 25, T. 21 N., R. 5 W. This sand is best developed in the south-central part of the field.

It is the writers' opinion that there will be no problem, in the Lisbon field, of edge-water encroachment due to the presence of salt water within the Patton zone. However, wells which have been drilled into the salt-water sand below the Patton zone and plugged back, may eventually, because of later acid treatments, show appreciable leakage of salt water upward into the Patton zone. Such leakage probably will lead to longer pumping lives and greater oil recoveries for these particular wells. The low permeabilities of the limestones of the Patton zone probably will not allow rapid movement of these leakage waters over any appreciable part of the field, since its rate of movement will be slower than the rate of oil withdrawals.

GAS-OIL RATIO; BOTTOM-HOLE PRESSURES

The original gas-oil ratios of the Lisbon field were very low, ranging in value from 50 to 300 cubic feet per barrel. The present gas-oil ratios are in most cases below 2,000 cubic feet per barrel.

The rapid increase of the gas-oil ratios of many wells in the Lisbon field, after several months of production and repeated acid treatments, indicates that there is no definite gas-oil level in the Patton zone definable in terms of subsea contours on the top of this zone.

The Lisbon oil is an undersaturated oil; the original gas-oil ratios indicate that the amount of free gas in the reservoir was very limited. With continued production, gas-oil ratios have shown an abnormal rate of increase. It is the writers' opinion that tight limestone lentils of low porosity, within the oil-bearing porous limestones of the Patton zone, are gas saturated. Release of pressure, as production goes on, coupled with the effect of acid treatment, allows escape of this gas with consequent increase in gas-oil ratios, to values above those which might be expected from an undersaturated oil.

Wells completed in the Lisbon field have not shown bottom-hole pressures greater than 1,890 pounds corrected to the minus 4,850-foot datum. An average reservoir pressure as of July 15, 1937, compiled from Louisiana Conservation Department figures based on 28 wells, was 1,371 pounds per square inch. During the 6-month period ending January 15, 1938, The Lisbon field showed an average reservoir-pressure decline of 286 pounds. During this same period the Lisbon field produced more than 283,000 barrels. This 6-month decline of 286 pounds is equivalent to a pressure drop per barrel of 0.00101 pound.

Certain wells in the field on which there are available data, have shown pressure-drop ratios as high as 0.0555 and 0.0147 for approximately the same 6-month period (Table XI).

OIL CONTENT AND ESTIMATED RECOVERY

Reference to Table VIII shows that the oil content by volume of cores is low, no doubt due in part to fluid loss in bringing cores to the surface. The factors used in estimating the ultimate recovery of the Lisbon field are as follows.

1. Area of 4,100 acres as of January 1, 1938
2. Average thickness of saturated porous zone 12.6 feet
3. Weighted average oil content by volume 5 per cent
4. Average 20 per cent porosity

Factors 1 and 2 are equivalent to 51,760 acre-feet of oil-saturated limestone.

Using factors 3 and 4, it is estimated that an ultimate expectancy of 250 barrels per acre-foot is not beyond reason, under proper conservation of all available reservoir energy.

Using these factors, it is estimated that an original 12,900,000 barrels of recoverable oil underlay the 4,100 acres of the Lisbon field. The accumulative production of the Lisbon field as of January 1, 1938, is 2,440,640 barrels. A reserve of approximately 10,500,000 barrels as of January 1, 1938, is forecast for the Lisbon field.

DRILLING METHODS AND PRACTICES

Rotary drilling is used exclusively in the Lisbon field. Weight indicators, straight-hole reamers, and, in some instances, bottom joints of oversize drill stem are used for maintenance of straight hole. Louisiana Conservation Department rulings call for straight-hole measurements at 500-foot intervals, with a maximum allowable tolerance of 5° from vertical. It is thought that most of the wells in the Lisbon field are comparatively straight as a result of the precautions followed in drilling operations.

Twenty-four to 30 days is the average completion time for wells in the Lisbon field.

Louisiana Conservation Department rulings specify a surface string of 9 5/8-inch or 10 3/4-inch casing to be set at an approximate depth of 800 feet. The average amount of cement used for this surface string is 250 sacks.

Most operators set an oil string of 7-inch, 26-pound grade C casing just above, or on, the 2-foot limestone cap above the Patton "pay." Average length of 7-inch oil string varies from 5,100 to 5,200 feet, dependent on structural position of well. Customary tubing program on well completion calls for 2½-inch, 6½-pound upset tubing with an 8–10-foot perforated plug joint on bottom. Some operators follow the practice of setting 4½-inch perforated liner on bottom. Oil is usually employed in displacing drilling mud from oil string.

Acid treatment of wells prior to completion has been the customary procedure followed by some operators. Other operators do not acidize wells unless these wells show a tight pay section and fail to make allowables on completion. The average acid treatment varies from 3,000 to 5,000 gallons of 15 per cent hydrochloric acid.

Surface water supply for drilling operations is ample except in extremely dry weather when it is necessary to drill water wells to an approximate depth of 600 feet. Supply from one water well is generally sufficient for several rigs in its vicinity.

During early developments, natural gas from the Sugar Creek field and oil from the Lisbon field were used as fuel in drilling operations. Subsequent development of an adequate supply of gas in the field itself has displaced the usage of fuel oil and purchased gas from outside sources.

Most operators maintain a close supervision over mud weights and viscosities. An average mud weight of 10½–11 pounds with viscosity of 35–40 seconds is customary.

During the early developments in the Lisbon field, it was customary to use a 2,500-pound test blow-out preventer on drilling wells. Later developments showed that this precautionary measure was not needed, since there are no high-pressure gas zones above the Patton "pay."

Development and Production History

The first outpost well located beyond the area immediately adjacent to the discovery well, was the Lisbon Oil Company's J. W. Burgess Est. No. 1 located in Sec. 3, T. 20 N., R. 5 W., approximately 2½ miles west of the discovery well. Operations were begun during January, 1937, on this well.

Due to poor core recovery through the pay section, an electrical survey was made which indicated 2½ feet of porous limestone in the Patton zone. Drilling was carried to a depth of 5,438 feet, approximately 400 feet below the top of the Travis Peak. This well was abandoned on April 6, 1937, as a dry hole, without setting casing to test the 2½ feet of porosity in the Patton zone. Later, as other wells in the field with a comparable pay thickness were completed as commercial wells following acid treatment, a string of casing was run in the Burgess well. During November, 1937, this well was treated with 5,000 gallons of acid; the well flowed for several days and went dead. It was then standardized and on January 1, 1938, was pumping an average of 100 barrels per day.

The second outpost well beyond the limits of the field, the Weaver-Perry Oil Company's Edmonds Est. No. 1, was located in Sec. 16, T. 20 N., R. 5 W., approximately 2½ miles southwest of the discovery

well. Operations on this well began during April, 1937. This well checked 254 feet lower structurally on the top of the Patton zone than the discovery well. Twelve feet of saturated limestone was cored with no indication of salt water. Porosity of the limestone pay averaged 12–14 per cent. Casing was set and the well was given a 5,000-gallon acid treatment, but failed to flow following treatment; a second treatment of 5,000 gallons, and finally a third treatment of 3,000 gallons were given, making a total of 13,000 gallons of acid used. The well was then standardized and has averaged 20 barrels per day pumping with no showing of salt water.

Drilling operations were begun during May, 1937, on the third outpost well of the Lisbon field, the T. L. James *et al.* Baker No. 1, in Sec. 25, T. 21 N., R. 5 W., located approximately one mile north of production. This well checked 130 feet higher structurally on the top of the Patton zone than the discovery well. Five feet of saturated limestone from the Patton zone was logged in an electrical survey. Cores which were recovered from the Patton zone had very low porosity, permeability, and saturation; consequently the well was carried deeper into the upper part of the Travis Peak. The Baker well was temporarily abandoned as a dry hole during June, 1937, at a total depth of 5,343 feet. As development of the Lisbon field progressed northward, several wells located between the Baker well and the field proper were completed as commercial producers. These wells logged a saturated Patton "pay" of comparable thickness with that of the Baker No. 1 and had responded very successfully to acid treatment. As a result of this development, casing was set in the Baker well and an acid treatment of 4,000 gallons was given. Subsequently the Baker well pumped 25 barrels per day for a short time but was finally abandoned as a non-commercial well.

To date, the Baker well is the highest well structurally in the Lisbon field proper and is the only abandoned well.

Maximum drilling operations in the Lisbon field were carried on during the first 6 months of 1937, the peak being reached during July, 1937, when 37 rigs were running.

Table IX shows pipe-line-run figures by months for the Lisbon field for the year 1937.

PIPE LINES

Two 6-inch pipe lines serve the Lisbon field.

The Gulf Pipe Line Company entered the field in April, 1937, approximately 3 months after the completion of the discovery well. This 6-inch line serves as an outlet for 10,000 barrels per day and is tied into the Gulf Pipe Line Company's 6-inch Haynesville-Homer line at Dubberly, Louisiana.

The Grogan Oil Company completed its 6-inch line into the Lisbon field during December, 1937. This line is tied into the Arkansas Pipe Line Company system at Homer, Louisiana, from which point oil is transferred to the Grogan Oil Company refinery located in Shreveport, Louisiana.

TABLE IX

OIL PRODUCTION, LISBON FIELD; PIPE-LINE RUNS SHOWN IN BARRELS; FOR YEAR 1937

January	620
February	7,219
March	5,080
April	47,167
May	153,662
June	342,012
July	415,126
August	414,759
September	409,012
October	156,106
November	204,709
December	285,170
Total	2,440,640

SUMMARIZED ANALYSIS OF LISBON CRUDE

Gravity	34.5° (corrected)
Flash	Below 60°
B. S.	.2 %
Sulphur	1.04%
Pour	Below 0°
Gasoline	25%
Naphtha	0

WELL SPACING

The first Louisiana Conservation Department ruling on well spacing for the Lisbon field was issued in April, 1937. This ruling was in keeping with common agreement among operators in the field and called for one well to 10 acres. This "one-well-to-10-acre" agreement was later modified to one well to 20 acres, by common agreement among operators.

It is the writers' opinion that a spacing of one well to 40 acres will give ultimate recoveries which will closely approximate recoveries under the 20-acre spacing. Usage of the newer acid-treatment technique will no doubt aid materially in a more uniform drainage of the Patton zone regardless of spacing. However, recoveries on a 10- or 20-acre spacing will not offset the added drilling costs required by the spacing as compared with the recovery from a 40-acre spacing with its lower development cost.

TABLE X

BASE ALLOWABLE FOR FIRST 4 WELLS

Company	Well and Location		Acres	Pounds Bottom-Hole Pressure	Acres	Pounds Bottom-Hole Pressure	Total	Cubic Feet, Gas Limit	Gas-Oil Ratio	Barrels Corrected Allowable
Lyons and Neely	H. E. Patton	36, 21N., 5W.	20	2,300	225	75	300	600,000	U-2,000	300
Oakes *et al.* (discovery)	Patton Est.	1, 20N., 5W.	20	2,300	225	75	300	600,000	U-2,000	300
Oden *et al.*	H. W. Patton	36, 21N., 5W.	20	2,300	225	75	300	600,000	U-2,000	300
Red Iron Drlg. Co.	H. E. Patton	36, 21N., 5W.	20	2,300	225	75	300	600,000	U-2,000	300
FIELD TOTAL—4			80	9,200	900	300	1,200	2,400,000		1,200

Proration was ordered in the Lisbon field in May, 1937; the first order was as follows.

Daily field allowable	1,200	barrels
Allocation to acreage	900	barrels
Allocation to bottom-hole pressure	300	pounds
Total field allocation	1,200	barrels
Area allotted to oil wells	80	acres
Acreage factor—one acre equals	11.25	barrels
Total bottom-hole pressures estimated	9,200	pounds
Bottom-hole pressure factor—one pound equals	0.03261	barrel

During May, 1937, when the first proration order was applied by the Louisiana Conservation Department, there were 4 producing wells in the Lisbon field. The proration order as applied to these 4 wells is outlined in Table X.

TABLE XI

PERTINENT DATA

1.	Discovery well and date—E. T. Oakes, Patton No. 1, Sec. 1, T. 20 N., R. 5 W., December 24, 1936. Total depth, 5,372 feet. Estimated initial production, 100 barrels flowing.		
2.	Proved area, January 1, 1938	4,100	acres
3.	Oil-reservoir content as of January 1, 1938	51,760	acre-feet
4.	Accumulative production January 1, 1938	2,440,640	barrels
5.	Recoverable reserves	10,500,000	barrels
6.	Number of producing wells, January 15, 1938. Flowing, 112; pumping 51	163	
7.	Production rate		
	A. Average daily well allowable, January 1, 1938	61	barrels
	B. Field allowable, January 1, 1938	10,000	barrels
8.	Reported average reservoir pressure by Louisiana Conservation Department as of July 15, 1937, from 28 wells	1,371	pounds
9.	Reported average reservoir pressure by Louisiana Conservation Department as of January 15, 1938, from 59 wells	1,085	pounds
10.	Average reservoir-pressure decline (July 15, 1937, to January 15, 1938)	286	pounds
11.	Average reservoir-pressure decline in pounds per square inch per barrel of oil produced for same period	0.00101	pounds
12.	Maximum Patton pay thickness	21	feet
13.	Minimum Patton pay thickness	2.5	feet
14.	Average Patton pay thickness	12.6	feet
15.	Average acid treatment	4,000	gallons

Peak production of the Lisbon field was reached during October, 1937, when the greatest allowable was 15,000 barrels per day. On February 1, 1938, a State proration order was issued and allocated as follows.

Daily field allowable	10,000	barrels
Augmented daily field allowable	10,100	barrels
Allocation to acreage	7,575	barrels
Allocation to bottom-hole pressure	2,525	barrels
Total field allocation	10,100	barrels
Area allotted to oil wells	3,252.3	acres
Acreage factor—one acre equals	2.32912	barrels
Total bottom-hole pressure	182,554	pounds
Bottom-hole factor—one pound equals	0.01383	barrel

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STRATIGRAPHY OF OSAGE SUBSERIES OF NORTHEASTERN OKLAHOMA[1]

L. R. LAUDON[2]
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ABSTRACT

Detailed stratigraphic sections have been measured throughout the area of exposure of the Osage subseries of the Mississippian series in northeastern Oklahoma. Faunal collections from each of the recognizable zones within the formations have been made throughout the area. The main essentials of the stratigraphy of this series have been outlined by L. M. Cline in his more generalized report on southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma. This report is designed to substantiate evidence advanced by Cline and to bring into print a large number of the best exposed sections in the region.

The writer wishes to acknowledge the work of Clarence Brehm and Edward Lane, of Tulsa, in assisting in preparation of the sections; and the work of Lewis M. Cline, of Iowa State College, in field assistance.

INTRODUCTION

Rocks of the Mississippian series of the Carboniferous system are excellently exposed in northeastern Oklahoma along the edge of the Ozark uplift. The Mississippian series as exposed in northeastern Oklahoma is represented by three of the standard subseries as defined in the type area in the upper Mississippi valley. The Kinderhook subseries is represented by the Sylamore sandstone and the Chattanooga shale; the Osage subseries by the St. Joe, Reeds Spring, and Keokuk formations; and the Chester subseries by the Mayes, Fayetteville, and Pitkin formations. So far as the writer has been able to determine, the Meramec subseries as exposed in the upper Mississippi valley is not represented in the section in northeastern Oklahoma.

The Osage subseries of northeastern Oklahoma is represented by three formations: the St. Joe at the base, followed in ascending order by Reeds Spring and Keokuk formations. The Burlington formation so excellently exposed in southwestern Missouri around Springfield is not developed in northeastern Oklahoma.[3] As far as can be determined, there are no rocks in northeastern Oklahoma that are to be correlated with the Warsaw formation as exposed in the upper Mississippi valley.

ST. JOE FORMATION

The St. Joe formation is the most variable in the northeastern Oklahoma Osage section. It is characterized by sudden lateral varia-

[1] Manuscript received, November 9, 1938.

[2] Associate professor of geology, University of Tulsa.

[3] See L. M. Cline, "Osage Formations of Southern Ozark Region, Missouri, Arkansas, and Oklahoma," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 18, No. 9 (September, 1934), pp. 1132–59.

tions in lithologic character and thickness. These variations are caused by a disconformity at the base and by the introduction of massive crinoidal bioherms[4] into the section. Normally the formation consists of thin-bedded, gray to bluish gray, slabby limestone beds that are not markedly fossiliferous. This condition is usually referred

TABLE I

STRATIGRAPHIC POSITION OF FORMATIONS

System	*Series*	*Subseries*	*Formation*
Carboniferous	Pennsylvanian	Des Moines	Atoka
		Bendian	Morrow Hale
	Mississippian	Chester	Pitkin Fayetteville Mayes
		Osage	Keokuk Reeds Spring St. Joe
		Kinderhook	Chattanooga Sylamore
Devonian	Onondaga		Sallisaw
	Oriskany		Little Saline
Silurian	Niagaran		St. Claire
Ordovician	Cincinnatian		Fernvale
	Black River		Fite Tyner
	Chazyan		Burgen
	Canadian		Cotter

to as the "non-reef phase." The "reef phase" is characterized by lenticular masses of exceptionally crinoidal limestone interbedded with green, gray, and red, highly fossiliferous marls. These lenticular bioherms vary in size from a few feet in length to as much as 2 miles and from the thickness of one bed to as much as 80 feet. The fossils in the crinoidal limestone are generally much broken with complete crinoid calyces occurring only rarely. Single valves of the larger brachiopods are commonly preserved in the crinoidal limestone. The

[4] E. R. Cummins, "Reefs or Bioherms," *Bull. Geol. Soc. America*, Vol. 43 (1932), pp. 331–52.

most excellently preserved fossils occur in the marly layers found interbedded with the crinoidal limestone.

The fauna of the St. Joe formation is sufficiently diagnostic to be easily distinguishable from that of the succeeding formations. Although many of the species occur higher in the Osage section, the following assemblage of forms may be considered diagnostic of the formation: *Cyathaxonia arcuata* Weller, *Schizoblastus moorei* Cline, *Evactinopora sexradiatus* M. and W., *Rhipidomella oweni* Hall and Clarke, *Dictyoclostus fernglenensis* (Weller), *Spirifer rowleyi* Weller, *Spirifer vernonensis* Swallow, *Brachythyris suborbicularis* (Hall), *Athyris lamellosa* (Leveille), *Cliothyridina prouti* (Swallow), and *Platyceras paralius* W. and W.

The St. Joe formation is a correlative of the Fern Glen of southeastern Missouri,[5] the New Providence of western Kentucky and Tennessee,[6] and the Lake Valley of New Mexico.[7]

Throughout this area the St. Joe and its correlatives are characterized by these massive crinoidal bioherms. Much of the early crinoid collecting by Springer[8] in the "Knobstone formation"[9] came from the famous "Button Mould Knob" and "Kenwood Hill" bioherms of the New Providence formation in the vicinity of Louisville, Kentucky. Field work in this area ranging from the "Knobs" of Kentucky to the Lake Valley region has demonstrated to the writer that the crinoidal bioherms of the early Osage have a distinctive character not found in any other formation. Crinoidal bioherms are excellently developed in the Lake Valley formation in the Sacramento Range east of Alamogordo, New Mexico.[10] They attain thicknesses of more than 400 feet in this area. Both "reef" and "non-reef" phases are well developed in the Lake Valley region.

Typical early Osage faunas occur in the lower part of the Madison limestone section in the Bridger Mountains north of Bozeman, Montana. It seems apparent that the early Osage faunas are by far the most widespread of any of the Mississippian faunas in North America.

[5] R. C. Moore, "Early Mississippian Formations in Missouri," *Missouri Bur. Geol. and Mines*, Vol. 21, 2nd ser. (1928), pp. 165–66.

[6] Charles Butts, "The Mississippian Series of Eastern Kentucky," *Kentucky Geol. Survey* (6), Vol. 7 (1922), p. 188.

[7] Stuart Weller, "Fauna of the Fern Glen Formation," *Bull. Geol. Soc. America*, Vol. 20 (1909), pp. 265–322.

[8] Frank Springer, "Crinoid Fauna of the Knobstone Formation," *Proc. U. S. Nat. Mus.*, Vol. 41 (1911), pp. 175–208.

[9] S. S. Lyon, "Stratigraphical Arrangement of the Rocks of Kentucky," *Trans. Acad. Sci., St. Louis*, Vol. 1 (1860), pp. 612–21.

[10] N. H. Darton, "Comparison of the Paleozoic Section in Southern New Mexico," *U. S. Geol. Survey Prof. Paper 108* (1917), p. 49.

REEDS SPRING FORMATION

The Reeds Spring formation in northeastern Oklahoma consists of dark, bluish gray, thin-bedded, exceptionally cherty limestone. The cherts of the Reeds Spring are almost invariably dark in color. Locally in the upper part of the section lighter-colored cherts are developed. The thickness varies from 186 feet along Grand River southwest of Grove to as little as 21 feet in the sections north of Marble City. The contact of the Reeds Spring formation with the underlying St. Joe in most places appears to be conformable. In many places, the St. Joe grades imperceptibly into the overlying Reeds Spring. In the area north of Tahlequah along the Illinois River the contact with the St. Joe is sharp with local appearances of unconformity. The writer has long held the opinion that a slight disconformity separates the two formations but he does not have conclusive evidence to prove it.

In Oklahoma the Reeds Spring formation is decidedly barren of fossils. One faunal zone normally occurring about 70 feet above the base was located by Cline[11] on Spring Creek. This zone has been located in many other sections since its discovery by Cline. It is characterized by a large new variety of *Dictyoclostus fernglenensis* (Weller), *Schizoporia postriatula* Weller, *Spirifer vernonensis* Swallow, and *Cladoconus americanus* Weller. With the exception of the large variety of *D. fernglenensis* (Weller) all forms occur commonly in the underlying St. Joe formation. They are much more closely related to the St. Joe fauna than to higher Osage formations.

The Reeds Spring formation is exceptionally fossiliferous at the type section at Reeds Spring, Missouri. Here a typical St. Joe fauna is developed. Another fossiliferous zone occurs in the bluff of War Eagle Creek one half mile downstream from the War Eagle postoffice in Arkansas. Here also the forms are typical of the St. Joe formation.

The Reeds Spring has no correlatives outside the type area in southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma. Moore[12] has recognized beds of Reeds Spring age in the Fern Glen sections exposed in southeastern Missouri. Cherty limestones lithologically similar to the Reeds Spring occur in the Lake Valley area in New Mexico. Whether they will eventually turn out to be correlatives of the Reeds Spring can not be determined at present.

[11] L. M. Cline, *op. cit.*, p. 1144.

[12] R. C. Moore, "Early Osage, Mississippian, Beds of the Ozark Region," abstract, *Bull. Geol. Soc. America*, Vol. 44 (1933), p. 203.

KEOKUK FORMATION

In northeastern Oklahoma the Keokuk formation normally consists of massive, light buff-colored, fossiliferous chert. Locally the chert is interbedded with bluish gray crinoidal limestone ledges. Many of the chert beds are more than one foot in thickness. It is sharply disconformable with the underlying Reeds Spring throughout northeastern Oklahoma. The Burlington formation so excellently developed in northeastern Arkansas and southwestern Missouri is not present in northeastern Oklahoma sections. The variation in thickness of the Keokuk is due to unconformities both at its base and at its top.

Keokuk cherts are exceptionally fossiliferous throughout northeastern Oklahoma. The basal part of the section is considerably more fossiliferous than the upper ledges. Commonly occurring forms are: *Diaphragmus elegans* (Norwood and Pratten), *Orthotetes keokuk* (Hall), *Tetracamera subtrigona* (Meek and Worthen), *Delthyris similis* (Weller), *Spirifer logani* Hall, and *Reticularia pseudolineata* (Hall). Many other species occur in places but these common forms can be found at almost every exposure. This faunal assemblage is not the typical Keokuk assemblage of the type section at Keokuk, Iowa. However, this faunal assemblage does occur lower in the section in what is commonly called the transition zone between Burlington and Keokuk in the type area in the upper Mississippi valley. The lower buff cherty limestone ledges that lie below typical dark blue limestone in the type area were designated as Montrose cherts by Keyes[13] in 1895. The fauna of these beds is almost identical with the fauna of the Keokuk cherts of Oklahoma.

STRATIGRAPHIC SECTIONS

Many stratigraphic sections of the Osage subseries of northeastern Oklahoma have been studied in detail. These sections range in location from a few miles north of Wyandotte southward to the region near Marble City. Wherever more or less complete sections were found they have been measured. From these, twelve have been chosen which best show the stratigraphy from north to south in the area of exposure.

Wyandotte section (Fig. 1).—The Wyandotte section is located in the southeast bluff of Grand River west of Wyandotte in the NW. ¼ of Sec. 31, T. 27 N., R. 24 E.

The St. Joe formation in the Wynadotte area is quite different from its normal development in areas farther south. It is characterized by an exceptionally thick development of the "non-reef phase."

[13] Charles Keyes, "Geology of Des Moines County, Iowa," *Iowa Geol. Survey*, Vol. 3 (1895), p. 341.

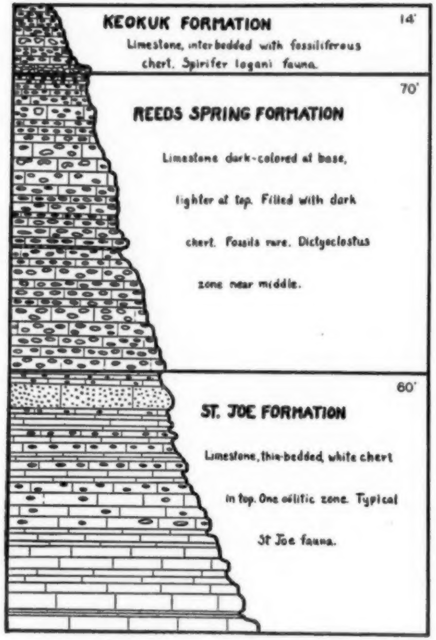

FIG. 1.—Wyandotte section, southeast bluff of Grand River, west of Wyandotte, NW. ¼ of Sec. 31, T. 27 N., R. 24 E. Thickness in feet.

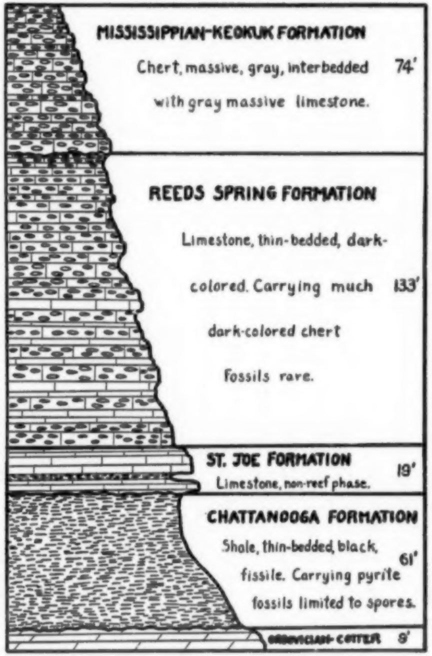

FIG. 2.—Grand River section No. 1, southeast bluff of Grand River, 6 miles north of Grove, SW. ¼ of Sec. 31, T. 26 N., R. 24 E. Thickness in feet.

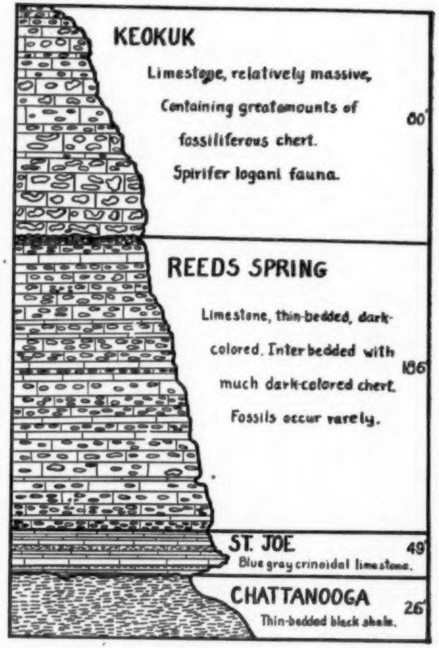

FIG. 3.—Grand River section No. 2, southeast bluff of Grand River, 4 miles southwest of Grove, center of Sec. 22, T. 24 N., R. 23 E. Thickness in feet.

Most of the rock consists of dense blue relatively unfossiliferous limestone. This condition is also found in the St. Joe formation throughout southwestern Missouri and the extreme northwestern part of Arkansas.

The occurrence of a continuous bed of oölitic limestone a short distance from the top of the St. Joe formation in this area has led to considerable confusion. The oölitic limestone has been considered as a correlative of the Short Creek oölite which lies on top of the Keokuk beds in southwestern Missouri.

The Reeds Spring formation is thin in this area due to truncation before the deposition of the Keokuk cherts. This erosion apparently took place at the time of normal Burlington limestone deposition.

Grand River section No. 1 (Fig. 2).—Grand River section No. 1 is located in the southeast bluff of Grand River, 6 miles north of Grove in the SW. ¼ of Sec. 31, T. 26 N., R. 24 E.

This section is the normal type found throughout the area. The St. Joe formation is thin and exhibits the "non-reef phase." The contact between the Reeds Spring and underlying St. Joe is sharp. The Reeds Spring continues to thicken by addition of beds at the top due to less erosion before the deposition of the Keokuk.

Grand River section No. 2 (Fig. 3).—Grand River section No. 2 is located in the southeast bluff of Grand River 4 miles southwest of Grove in the center of Sec. 22, T. 24 N., R. 23 E.

The lower part of the St. Joe formation contains a very fossiliferous crinoidal bioherm in this section from which a considerable number of complete crinoid calyces were collected.

The Reeds Spring formation reaches its maximum development of 186 feet in this section. The contact between Keokuk and Reeds Spring is unconformable. The basal Keokuk cherts are very fossiliferous but the upper part of the section is relatively unfossiliferous.

Grand River section No. 3 (Fig. 4).—Grand River section No. 3 is located in the east bluff of Grand River opposite Tynon Bluff in the NW. ¼ of Sec. 4, T. 23 N., R. 22 E.

This section is located a few miles above the present Grand River dam site within the area that will be flooded by the lake. The St. Joe formation exhibits its most excellent development of a crinoidal bioherm in this section. The entire formation consists of loosely cemented crinoidal limestone. Massive ledges consisting almost entirely of crinoidal fragments occupy the whole middle part of the section. Fossiliferous marly layers occur at intervals throughout the section.

The Reeds Spring formation shows considerable thickening as the erosion between it and the overlying Keokuk becomes less toward the south.

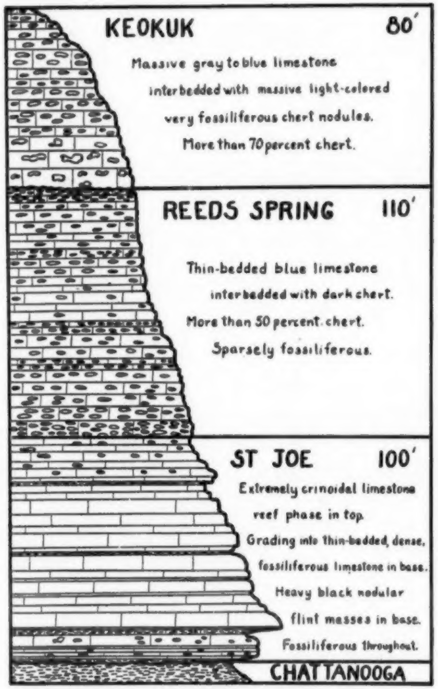

FIG. 4.—Grand River section No. 3, east bluff of Grand River, NW. ¼ of Sec. 4, T. 23 N., R. 22 E. Thickness in feet.

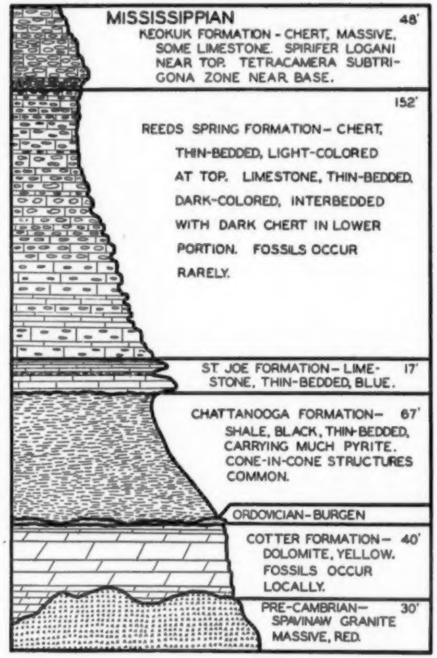

FIG. 5.—Spavinaw section, south bluff of Spavinaw Creek, below dam. Thickness in feet.

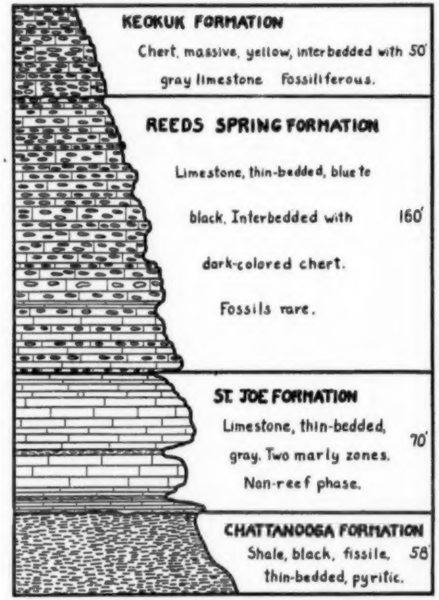

FIG. 6.—Eucha section, north bluff of Spavinaw Creek, 2 miles east of Eucha, NW. ¼ of Sec. 33, T. 22 N., R. 23 E. Thickness in feet.

Spavinaw section (Fig. 5).—The Spavinaw section is located in the south bluff of Spavinaw Creek immediately downstream from the dam at Spavinaw, Oklahoma.

This section was published by the writer[14] in the Tulsa Geological Society *Digest* for 1937. The section accompanying the 1937 report shows an unconformity at the top of the St. Joe formation. Because of lack of conclusive evidence to the contrary the sections in the present paper are shown with the St. Joe conformably overlain by the Reeds Spring.

The Reeds Spring formation is considerably thinner in this area due to erosion before the deposition of the Keokuk cherts.

The massive Keokuk cherts at the top of the bluff are exceptionally fossiliferous in this section. Excellent fossils may be obtained by breaking the massive chert nodules.

Eucha section (Fig. 6).—The Eucha section is located in the north bluff of Spavinaw Creek 2 miles east of Eucha, Oklahoma.

The St. Joe formation exhibits an exceptional development in this section, both "reef and non-reef phases" being present. Most of the limestone consists of dense blue relatively unfossiliferous rock. Two crinoidal bioherms are developed in the section, however. The Keokuk cherts are richly fossiliferous here also.

Barren Fork section (Fig. 7).—The Barren Fork section is located in the south bluff of Barren Fork of the Illinois River one mile southeast of the town of Barren, Oklahoma, in the S. center of Sec. 25, T. 15 N., R. 25 E.

The St. Joe formation consists of about 3 feet of gray, hard, relatively unfossiliferous limestone. This thin slabby phase is characteristic of much of the southern part of the area of exposure of the Osage subseries. The Reeds Spring reaches a thickness nearly equal to that developed in the Grand River section southwest of Grove. The Keokuk cherts are poorly fossiliferous in this section.

Eagle's Nest section (Fig. 8).—The Eagle's Nest section is located in the west bluff of Illinois River in the center of the NW. $\frac{1}{4}$ of Sec. 24, T. 18 N., R. 22 E.

This section was also published by the writer[15] in the Tulsa Geological Society *Digest* for 1937. The same condition exists with regard to the possible disconformity between the Reeds Spring formation and the underlying St. Joe.

The St. Joe formation exhibits a very exceptional crinoidal bioherm

[14] L. R. Laudon, "Mississippian of Northeastern Oklahoma," *Tulsa Geol. Soc. Digest* (1937), p. 2.

[15] L. R. Laudon, *op. cit.*

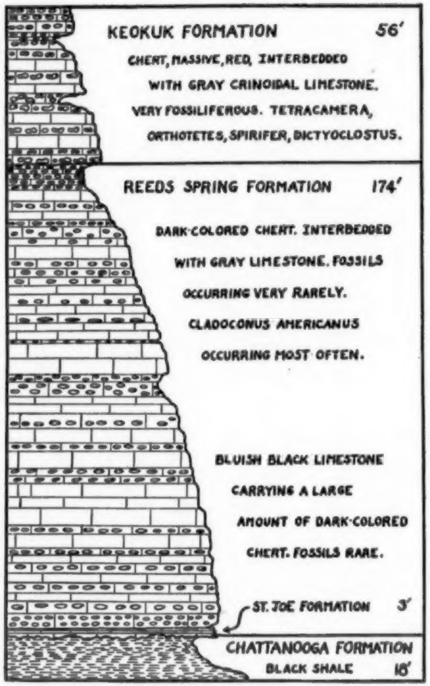

FIG. 7.—Barren Fork section, south bluff of Barren Fork of Illinois River, 1 mile southeast of Barren, S. center of Sec. 25, T. 15 N., R. 25 E. Thickness in feet.

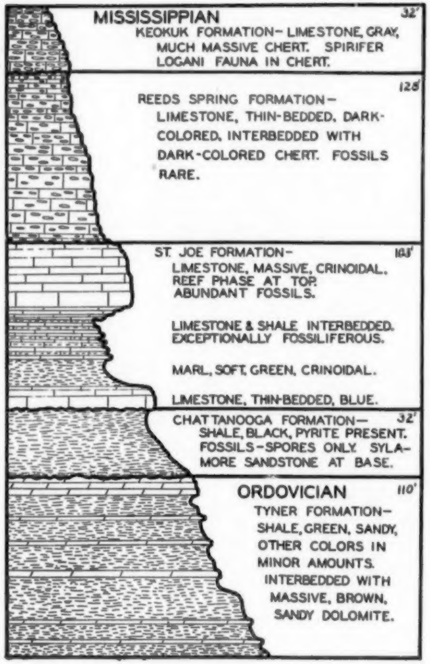

FIG. 8.—Eagle's Nest section, west bluff of Illinois River, center of NW. ¼ of Sec. 24, T. 18 N., R. 22 E. Thickness in feet.

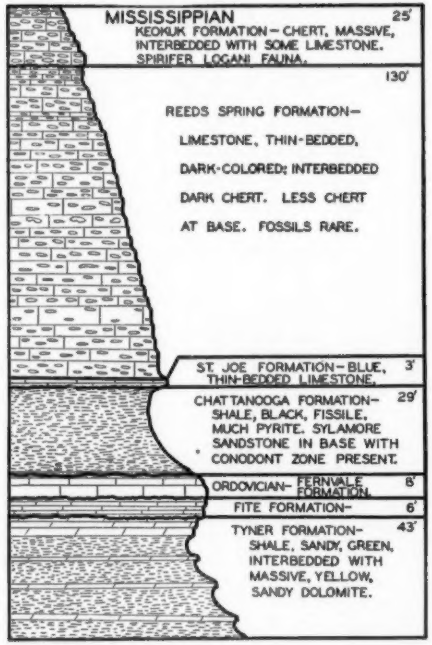

FIG. 9.—Illinois River section No. 1, south bluff of Illinois River, 5 miles northeast of Tahlequah, SE. ¼ of Sec. 12, T. 17 N., R. 22 E. Thickness in feet.

in this section. The lower bed in the section consists of the ordinary gray, thin-bedded, slabby, relatively unfossiliferous limestone. This bed is overlain by soft gray calcareous marl completely filled with fragmented crinoids. This marl member resembles the material found in the bioherms of the New Providence formation at Button Mould Knob and Kenwood Hill near Louisville, Kentucky. The marl member is overlain by soft, thin-bedded, black, shaly limestone containing an exceptionally large fauna of brachiopods, bryozoans, and crinoids. The black member is overlain by soft blue-gray extraordinarily fossiliferous crinoidal limestone. The thick upper part of the section consists of the ordinary gray, massive, extremely crinoidal limestone ledges so typical of the bioherms of the region. Excellent fossils may be collected from the bedding planes of this upper member.

The contact between the St. Joe and Reeds Spring formations occurs with knife-like sharpness. Local evidences of solution occur along the contact. The crinoidal limestones of the reef phase are cut off with equal sharpness. The Reeds Spring formation shows a thinning which corresponds closely with the extra thickness of the St. Joe formation. Less than half a mile south of the Eagle's Nest section, the St. Joe contains only the basal slabby limestone member slightly more than 3 feet in thickness. The Reeds Spring has thickened accordingly in this section.

Illinois River section No. 1 (Fig. 9).—Illinois River section No. 1 is located in the south bluff of Illinois River 5 miles northeast of Tahlequah, Oklahoma, in the SE. ¼ of Sec. 12, T. 17 N., R. 22 E.

The St. Joe formation exhibits its typical thin-bedded, slabby phase in this section. The Reeds Spring has about the same thickness seen in the section at Eagle's Nest where the St. Joe is more than 100 feet in thickness. The Keokuk cherts are sparsely fossiliferous in this section.

Illinois River section No. 2 (Fig. 10).—Illinois River section No. 2 is located in the south bluff of Illinois River 7 miles southeast of Tahlequah, Oklahoma, in the SE. ¼ of Sec. 25, T. 16 N., R. 22 E.

The St. Joe formation is not present in this section at all. The Reeds Spring is slightly thicker than in the sections along the Illinois River north of Tahlequah. The Keokuk formation contains plentiful fossils at this point.

Marble City section No. 1 (Fig. 11).—Marble City section No. 1 is located in the west face of the mountain 2 miles northwest of Marble City, Oklahoma, in the NW. ¼ of Sec. 15, T. 13 N., R. 23 E.

One thin bed at the base of the section represents the St. Joe formation. The base of the Reeds Spring formation is present and is

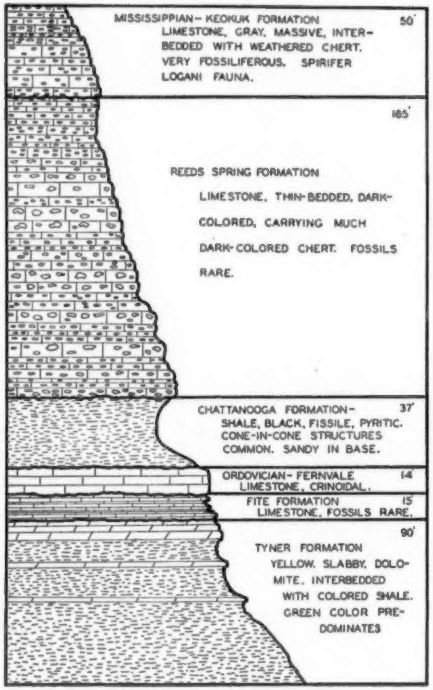

FIG. 10.—Illinois River section No. 2, south bluff of Illinois River, 7 miles southeast of Tahlequah, SE. ¼ of Sec. 25, T. 16 N., R. 22 E. Thickness in feet.

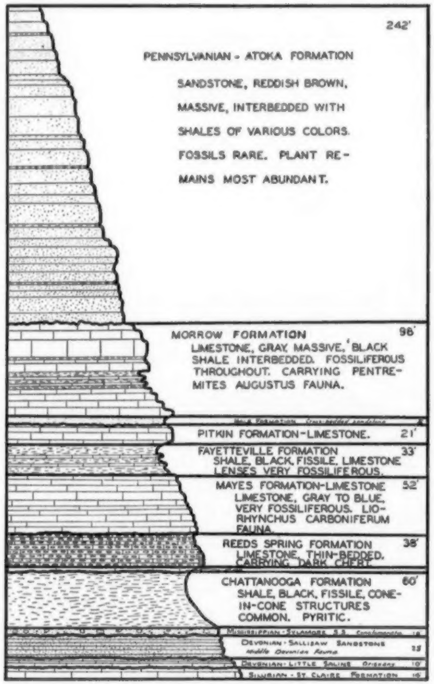

FIG. 11.—Marble City section No. 1, west face of mountain, 2 miles north of Marble City, NW. ¼ of Sec. 15, T. 13 N., R. 23 E. Thickness in feet.

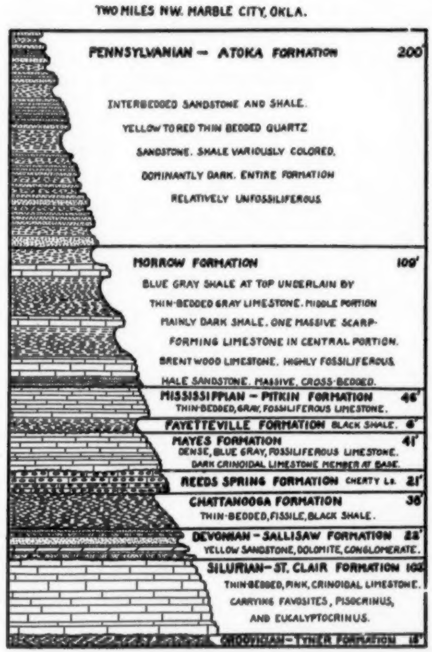

FIG. 12.—Marble City section No. 2, south face of mountain, 2 miles northwest of Marble City, SW. ¼ of Sec. 14, T. 13 N., R. 23 E. Thickness in feet.

unconformably overlain by the Mayes limestone. Pre-Chester erosion has removed all of the Keokuk formation and a large part of the Reeds Spring. A few miles north, in Walking Stick Hollow, nearly a full section of Reeds Spring and Keokuk may be seen.

Marble City section No. 2 (Fig. 12).—Marble City section No. 2 is located in the south face of the mountain 2 miles northwest of Marble City, Oklahoma, in the SW. ¼ of Sec. 14, T. 13 N., R. 23 E.

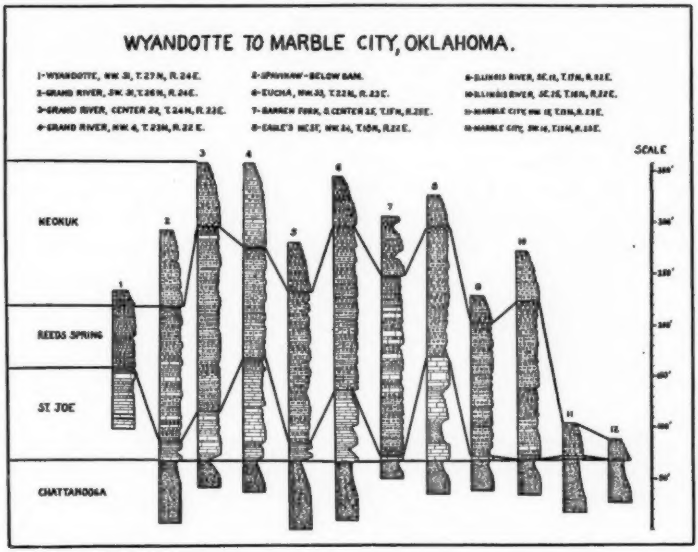

FIG. 13.—Correlation of sections, from Wyandotte southward to Marble City, Oklahoma. Thickness in feet.

The St. Joe formation is missing entirely in this section and the Reeds Spring is represented by only 21 feet of strata. Here also, pre-Chester erosion has removed the upper part of the section.

STRATIGRAPHY

The St. Joe formation rests unconformably on the underlying Chattanooga formation throughout the area. The contact zone of the St. Joe in most places is a mixture of reworked Chattanooga shale and bluish green St. Joe marly limestone. The relief of the Chattanooga surface does not appear to be great in the area in spite of the long time interval that elapsed between the deposition of the two formations.

Much greater relief occurs on the upper surface of the St. Joe formation. This relief is apparently in all places due to the introduction of the massive crinoidal bioherms. The exact relationship of the St. Joe to the overlying Reeds Spring is questionable. The faunas are closely related and if a disconformity does exist between the two formations it is certainly not of much time importance.

The "non-reef phase" of the St. Joe thickens northward in Oklahoma. The dense blue limestone ledges in the vicinity of Wyandotte are very similar to the type found in the Pierson limestone in the vicinity of Springfield, Missouri. Southward the St. Joe is everywhere thin, or in places entirely missing.

The Reeds Spring formation retains a much more constant interval throughout the region than the underlying St. Joe formation. Variations in thickness were produced by erosion during Burlington time before the deposition of the Keokuk formation. This erosion was more intense in the northern area. The Burlington limestone so excellently developed in northwestern Arkansas and in the region around Springfield in southwestern Missouri is not present in Oklahoma at all.

The Keokuk formation as developed in Oklahoma probably represents the early part of the Keokuk as developed in the type area. In southwestern Missouri the Keokuk is overlain by limestones containing a Warsaw fauna. These beds are not present in the Oklahoma section.

The entire Osage section is truncated in the southern area around Marble City so that only the basal part of the Reeds Spring formation is represented. The Mayes formation lies on the eroded surface. In the bluffs north of Marble City, Cline[16] located one section in which the only part of the Osage section that remained was a chert conglomerate in the base of the Mayes.

The Welden and Sycamore limestones of the Arbuckle Mountain section are probably not correlatives of any part of the Osage section. The writer believes they should be classed with the Chester formations.

[16] L. M. Cline, *op. cit.*, p. 1157.

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VOL. 23, NO. 3 (MARCH, 1939), PP. 339-342, 2 FIGS.

GEOLOGICAL NOTES

UPPER CRETACEOUS CHALK IN CAP ROCK OF McFADDIN BEACH SALT DOME, JEFFERSON COUNTY, TEXAS[1]

E. P. TATUM[2]
Houston, Texas

Until the Humble Oil and Refining Company drilled its McFaddin State No. A-1, 5,300 feet off the coast of Jefferson County, Texas, on the McFaddin Beach prospect (Fig. 1), the only known material of Cretaceous age encountered on the Gulf Coast salt domes was re-

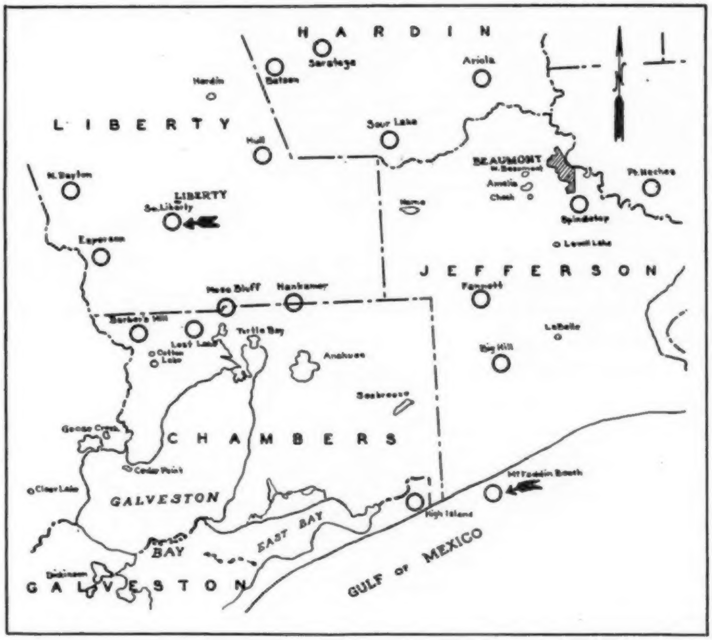

FIG. 1

[1] Published with the permission of the Humble Oil and Refining Company. Manuscript received, January 20, 1939.

[2] 1065 Humble Building.

ported by Morrison[3] from the limestone cap rock of the South Liberty salt dome (Fig. 1), Liberty County, Texas.

During the course of drilling McFaddin State No. A-1, which was completed, April 6, 1938, 25 feet of hard, light to dull gray, argillaceous chalk was cored. Its physical characteristics are very similar to those of cored specimens of Pecan Gap chalk from the wells of the East Texas basin.

The chalk contains a great abundance of indigenous Foraminifera of Upper Cretaceous age; a few of the more common ones are here listed.

Globotruncana arca (Cushman)
Globotruncana canaliculata (Reuss)
Globotruncana fornicata Plummer
Globigerina cretacea d'Orbigny
Clavulina trilatera Cushman
Planoglobulina acervulinoides (Egger)
Guembelina globulosa (Ehrenberg)
Guembelina plummerae Loetterle
Cibicides excolata (Cushman)
Ammodiscus cretacea (Reuss)
Textularia nacataensis White
Dorothia bulleta (Carsey)
Bulimina limbata White
Flabellina projecta (Carsey)
Gyroidina michelini d'Orbigny
Gyroidina depressa (Alth)
Gaudryina rugosa d'Orbigny

The chalk is a part of the selenite-anhydrite cap rock, occurring 226 feet below the top of the limestone cap rock, 165 feet below the top of the selenite-anhydrite cap rock and approximately 1,000 feet above the salt.

The drilled section of McFaddin No. A-1 is as follows.

Depths in Feet	
0–20	Water
1,355	Clays and sands of the Pleistocene and Recent
1,416	Porous, crystalline limestone cap rock
1,560	Selenite and anhydrite cap rock
1,581	No recovery. Cored hard, probably chalk
1,606	Chalk. Upper Cretaceous in age
1,752	Selenite and anhydrite cap rock
2,605	Anhydrite
2,655	Coarsely crystalline rock salt

To date three wells have been drilled on the McFaddin Beach salt dome. It will be seen from the cross section (Fig. 2) that McFaddin State No. A-1 has been the only well to encounter the chalk; however McFaddin State No. B-6 was drilled into the selenite-anhydrite sec-

[3] T. E. Morrison, "First Authentic Cretaceous Formation Found on Gulf Coast Salt Domes of Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 13, No. 8 (August, 1929).

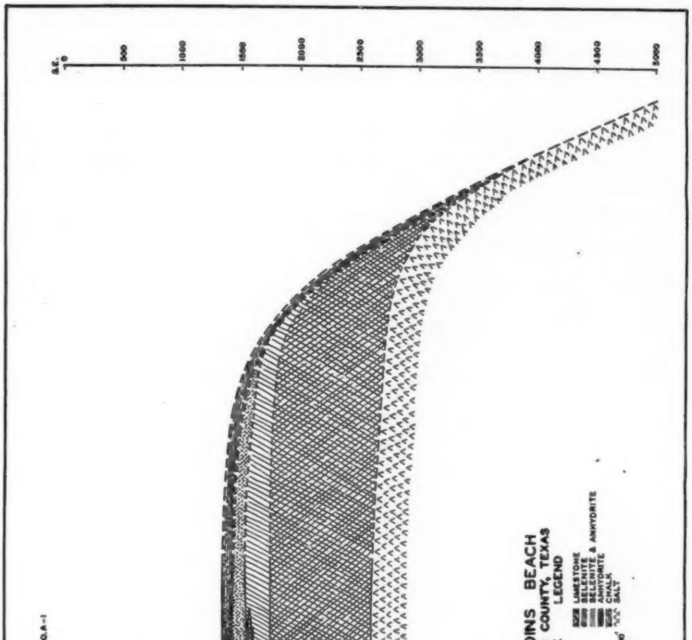
McFADDINS BEACH
JEFFERSON COUNTY, TEXAS
SCALE
LEGEND
LIMESTONE
SELENITE
SELENITE & ANHYDRITE
ANHYDRITE
CHALK
SALT
HUMBLE
HUMBLE
N.W.
S.E.

FIG. 2

tion a depth more than great enough to find the chalk had it been in the same position as in McFaddin State No. A-1, and McFaddin State No. B-8 was drilled through the limestone and anhydrite cap rock into salt without finding it.

This "block" of Upper Cretaceous chalk, found only in McFaddin State No. A-1, was probably detached from its original position by the upward movement of the salt and became a part of the residual accumulation of water-insoluble materials which make up the cap rock, and its presence in the cap rock does not indicate the age of the salt.

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DISCUSSION

RESEARCH AND THE RESEARCH COMMITTEE[1]

HENRY A. LEY
San Antonio, Texas

All about us we have a superabundance of inductive data. Uncoördinated facts are almost innumerable. These for the most part lack the synthetic thought and unifying philosophies so necessary to the advancement of the sciences. A calm skeptic may well hold that only the printer has profited from much of the theoretical approach to problems in this era of applied science. If a disciple of Spengler, he might well conclude that the naïve reliance placed in "iron men" is conclusive evidence that in a contemporary spiritual sense we are in the Winter Epoch—an epoch characterized by extinction of spiritual creative force.

It may not be amiss to make a new beginning by making a survey of the state of geology and its problems, and especially the manner of approaching the problems. Involved in these problems are questions and answers. Few men ask the questions, but many men have ready answers. Observe in the world of business and politics how few men ask questions and how many men have a ready answer or a comprehensive solution to all problems.

Attempting to analyze certain situations, the writer often philosophizes concerning the intellectual rank of questions and answers. A parrot can be taught to call out questions and answers, but a parrot can not by creative thinking put creative questions, except perhaps within the mental realm of bird life.

Reasoning, some believe, begins not with answers or premises, but with difficulties (questions). These difficulties or questions conceive hypothetical conclusions for which thought then seeks justifying answers.

There are probably no valid reasons why Research can not experiment along a new approach to geological problems. Instead of answers to these problems, sometimes monographs in size, why not comb men's minds for the questions which dimly or clearly arise again and again? Gather together the sum total of questions concerning each problem by questionnaires. Apply to these questions the necessary synthetic thought with the hope that unified philosophies may ultimately be evolved which answer the questions.

[1] Manuscript received, January 18, 1939.

PALEOGRAPHY[1]

RONALD K. DeFORD[2]
Midland, Texas

In one or two places recently I have seen the word *paleography* used instead of *paleogeography*. This is certainly bad etymology. To delete the *geo* is to cut out the *earth*, the very heart of the word.

The dictionary says that paleography is

> The study of ancient modes of writing including inscriptions; the art or science of deciphering ancient writings, determining their origin, period, *etc.*

The use of *paleography* for *paleogeography* can thus lead to confusion among non-geologists.

As the haplologic habit spreads and the geologic syncopators get seriously to work we may expect to see *paleontology* become *paleology;* but then *paleogeology* and *paleozoology* will also become *paleology*. This will greatly simplify the science; for one word will do the work of a dozen. Of course, no one will know exactly what the other fellow is talking about, but think of the saving in vocal energy, graphite, and printer's ink!

[1] Manuscript received, February 2, 1939.

[2] Geologist, Argo Oil Corporation.

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REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by an asterisk are in the Association library and available to members and associates.

GEOLOGICAL ANNUAL REVIEW, BY S. VON BUBNOFF *ET AL.*

REVIEW BY R. D. REED[1]
Los Angeles, California

Geologische Jahresberichte, unter Mitwirkung der Geologischen Vereinigung und zahlreicher Fachgenossen herausgeben von S. von Bubnoff. I. Band. A. *Allgemeine und historische Geologie*. Bericht über die Jahre 1936 und 1937. (*Geological Annual Review*, edited by S. von Bubnoff, with the collaboration of the Geologische Vereinigung and many geologists. Vol. I, A. *General and Historical Geology;* review for the years 1936–1937 (1938). 508 pp. Verlag von Gebrüder Borntraeger, Berlin. Price, RM40, paper bound.

Inspired by the example of Professor Schindewolf's *Fortschritte der Paläontologie*, Professor Serge von Bubnoff has undertaken the editorship of a new and different series of geological reviews. Each reviewer, of whom there are many, is a specialist in the particular field of his review, which constitutes an essay upon the recent advances in his field, with a running commentary upon the major articles published during 1936 and 1937. Section A, which is before us, deals with General and Historical Geology, but omits regional papers. Section B will deal with the latter.

Since this volume is a series of reviews, it may be interesting to consider at once the types of insufficiency to which reviews are particularly subject. It is a well known fact that good reviews and poor reviews look alike in many respects, and that the latter are very much the easier to write. Perhaps the commonest type of poor review is the superficial one that contains no solid data aside from what may be secured from the publisher's notice and the author's abstract, or at best from the author's introduction and conclusion. Very few of the reviews in the present collection seem to belong to this category, but a few of them suggest it in their more arid passages.

Another class of review that leaves something to be desired is that which tells the story of others' activities from a narrow, possibly from a prejudiced point of view. Instead of stressing the thoughts, arguments, and conclusions of the authors under review, it uses their writings chiefly as a source of arguments for what the reviewer takes to be the true faith. Such a review is hortatory rather than expository in tone, and in an extreme case may seem more like a piece of propaganda than a review. In the volume under consideration there is one example that suggests such reflections as these. It is Dr. E. Kraus' discussion of the publications dealing with Alpine tectonics. After reading this discussion one has a vivid idea of what Dr. Kraus thinks about Alpine tectonics, and of the extent to which he thinks his contemporaries share his views. Possibly the Kraus gospel is actually not quite so certain to prevail in the world within a generation as a careless reader of his review might imagine,

[1] Chief geologist, The Texas Company (California). Manuscript received, January 23, 1939.

but that is no reason why Dr. Kraus should not think so. His article is hardly to be criticized for improper presentation of his own views, as a matter of fact, but rather for failing to present adequately the views of other writers who dealt with the subject of Alpine tectonics during the years 1936 and 1937.

That a few of Professor von Bubnoff's reviewers should have failed to reach perfection is, however, less remarkable than the fact that so many of them should have come so near it. In order to give some idea of the contents and spirit of this notable and very useful contribution to geological science, I shall list each review, with author, number of pages, and in some cases with a typical quotation or a brief characterization.

INTRODUCTION

1. *Knowledge and doctrine*, by S. von Bubnoff, pp. 1–7, with list of references.

A turning away from mechanistic and positivistic ideas, as a reaction to the finally unfruitful scientific optimism of the 19th century, is unmistakable in geological literature . . .

Some of the writings of Bucher, Grabau, and Hubbert are among those in English that are cited as representative in one respect or another of the modern spirit.

GENERAL GEOLOGY

I. GENERAL SURVEY

1. *Advances in the physics of the earth as a whole and of the earth's crust*, by E. Tams, pp. 8–23, with many references.

A previously unrecognized discontinuity of the first order must, according to Jeffreys, be assumed to exist within the compressed rock mantle at a depth of approximately 480 km. . . .

In general the earth's crust is to be considered as in isostatic equilibrium, even though more or less important local and regional disturbances are present, . . .

Not much change here.

2. *Theories of Earth Evolution*, by S. von Bubnoff, pp. 23–32.

New theories of earth evolution have recently become scarcer, thank God.

An excellent brief review, citing among others, recent suggestions of Born, Chao, Cloos, DuToit, Fourmarier, Gutenberg, Kossmat, de Lury, Stille, F. E. Suess, Tromp, and Wegener.

II. MATERIALS

1. *The Magma*, by A. Streckeisen, pp. 33–49, with extensive bibliography.
2. *The Sediments.*

a. *Advances in the investigation of marine sediments and of the sea bottom*, by Otto Pratje, pp. 49–58.

Discusses new centers of investigation, regional problems, general questions, lime formation, heavy minerals, and methods.

b. *Limnic sediments*, by Paul Groschopf, pp. 69–80.

There is no longer any doubt that the origin of ancient sediments can only be understood and explained when we shall have become acquainted with the processes cur-

rently active in the sea and in the lakes. From technical reasons we are still temporarily better instructed about lake deposits . . .

Reviews the work in Scandinavia and Russia, as well as elsewhere.

3. *Useful deposits.*

a. *General, economical and statistical*, by G. Berg, pp. 80–85.

b. *Ores*, by G. Berg, pp. 86–104.

Reviews the different types of ore deposits, concluding with mention of some papers devoted to geophysics and of one devoted to the divining rod.

c. *Coal*, by E. Stach, pp. 104–115.

Coal formation is not merely a climatic but also a tectonic problem.

d. *Petroleum*, by Krejci-Graf, pp. 115–138.

An excellent summary, that will be of interest to all *Bulletin* readers who also read German.

e. *Salts*, by Ernst Fulda, pp. 139–142.

Dr. Fulda is still inclined to accept the Great Flood Hypothesis.

f. *Useful nonmetals*, by Fritz-Erdmann Klinger, pp. 142–149.

Galliher seems to have solved the problem of the origin of glauconite.

g. *Building materials and clays*, by Hans Udluft, pp. 149–154.

A good brief review, which scarcely looks beyond German occurrences.

III. TRANSFORMATION OF MATERIALS

1. *Depth Metamorphism*, by H. G. Backlund, pp. 155–165.

Reviews papers by such American geologists as Bain, Barth, Bridgman, Griggs, Gilluly, and Goodspeed, and by their co-workers in other lands. For most of us, these are papers to admire but not to read.

2. *Chemical geology and weathering*, by Hans Udluft, pp. 165–174.

Discusses among other things, the genesis of kaolin and montmorillonite.

3. *Soil Science*, by H. Stremme, pp. 174–185.

Gives an account of some recent soil maps and soil classifications. Bibliography includes many non-German works.

IV. ENDOGENOUS KINEMATICS AND DYNAMICS

1. *Petrofabrics*, by Ludwig Rüger, pp. 185–190.

Among other new accomplishments, Sander has recently applied petrofabric analysis to the petrographic and paleogeographic study of Triassic limestone and dolomite of the Calcareous Alps. Thus, future sedimentary petrographers are doomed to learn this new technique too, thinks Dr. Rüger.

2. *Plutonism*, by H. Cloos, pp. 191–202.

The definition of the subject and the nature of the task have been most completely presented in the National Research Council's Problems of the Batholiths [1936].

The list of references runs to four pages.

3. *Vulcanism*, by A. Rittmann, pp. 203–211.

Rittmann's review deals with new works by Escher, Tanakadate, Löwinson-Lessing, Jaggar, Stehn, Nielsen, Rust, Tyrrell, Richey and many others.

4a. *Alpine (Geosynclinal) Tectonics*, by E. Kraus, pp. 211–226.
4b. *Extra-Alpine Tectonics*, by Hans Stille, pp. 227–235.

Stille pays his particular respects to three recent volumes dealing comprehensively with tectonics: H. Cloos, "Einführung in die Geologie"; Franz Kossmat, "Paläogeographie und Tectonik"; and W. H. Bucher, "The Deformation of the Earth's Crust." He also summarizes very briefly the recent work of himself and his associates.

5. *Seismology*, by A. Sieberg, pp. 236–244.

Deals with earthquake maps, the problem of origin, depth of focus, and other subjects of geological interest. Seismic prospecting is mentioned very briefly.

V. EXOGENOUS PROCESSES

1. *Exogenous processes and topographic evolution in humid and arid regions*, by H. Spreitzer, pp. 245–268.

The voluminous publications are listed in several groups and briefly annotated.

2. *Ice formations and ice climate*, by E. von Drygalski, pp. 268–282.

Deals with varieties of ice, feeding and outflow areas, temperature and texture, movement and its effects, glacial fluctuations.

3. *Major topographic forms*, by A. Wurm, pp. 283–293.

The simplest subject treated seems to be the peneplain, which itself is becoming complicated.

4. *Hydrology (Groundwater and Springs)*, by K. Keilback, pp. 294–305.

VI. ACCESSORY SCIENCES

1. *Applied Geophysics*, by H. Reich, pp. 305–314.

Deals with gravimetric, magnetic, seismic and electrical methods, and with thermal measurements.

2. *Geotechnics and Military Geology*, by E. Wasmund, pp. 315–327.

HISTORICAL GEOLOGY

I. GENERAL

1. *On the history of geology*, by E. Haarmann, pp. 328–332.
2. *Age of the Earth*, by F. Kerner von Marilaun, pp. 332–336.
3. *Paleogeography*, by F. Kerner von Marilaun, pp. 336–341.

The most significant recent event in paleogeographic literature was the appearance of Kossmat's Paläogeographie und Tektonik.

4. *Paleoclimatology*, by F. Kerner von Marilaun, pp. 341–345.

Much about astronomical hypotheses.

II. THE ERAS AND PERIODS

1. *Pre-Cambrian*, Pentti Eskola, pp. 345–358. An excellent international review.

2. *Cambrian*, by B. Bouček, pp. 359–362.
3. *Silurian* (in broad sense) by B. Bouček, pp. 363–370.
4. *Devonian*, by Rud. Richter, pp. 370–383.
5. *Carboniferous and Permian*, by H. Schmidt, pp. 383–394.

A very technical summary, in which a high percentage of all the words used are names of fossils.

6. *Trias*, by Julius von Pia, pp. 394–410.

An international summary, beginning with Central Europe and ending with South America.

7. *Jurassic*, by Paul Dorn, pp. 410–417.
8. *Cretaceous*, by E. Voigt, pp. 417–429.
9. *Tertiary*, by E. Chaput and M. Gignoux, pp. 429–448.

An excellent summary, in French. Discusses the large Foraminifera, fossil mammals, sedimentary petrography, and the Paleogene and Neogene of all continents.

10. *Pleistocene.*

a. *Glaciated regions*, by Konrad Richter, pp. 448–465.

b. *Marine Quaternary and Sea-level Oscillations*, by Georges Dubois, pp. 465–470.

Another French review.

11. *Holocene* (*Postglacial, Alluvium*), by H. Gams, pp. 470–483.

Among other things, pollen analysis and tree ring studies.

The index of authors and subjects, pp. 484–508, concludes the work.

If succeeding volumes reach the high standards exemplified in this one, the series seems likely to become indispensable. The regional numbers may prove even more so to many of us than those devoted to general publications. The present reviewer, at any rate, looks forward with much interest to the appearance of the first regional volume.

GEOMECHANICS, BY GERHARD KIRSCH

REVIEW BY R. D. REED[1]
Los Angeles, California

Geomechanik, Entwurf zu einer Physik der Erdgeschichte (*Geomechanics: Sketch of a Physics of the Earth's History*), by Gerhard Kirsch. 151 pp., 43 figs. Verlag von Johann Ambrosius Barth, Leipzig (1938). RM14.80; bound, RM16.00.

Professor Kirsch is a physicist who has long lived under the spell of such seductive writers about earth problems as Sir John Joly, Arthur Holmes, and Alfred Wegener. In a book published as early as 1928 he reviewed the ideas of Joly and Holmes, in particular, and became much impressed with the po-

[1] Chief geologist, The Texas Company (California). Manuscript received, February 6, 1939.

tential efficacy of subcrustal magma currents as geological agents. Being a physicist, he was not content to lay this idea aside until he had attempted to estimate quantitatively the magnitude of as many as possible of the factors involved. In the present small volume, dedicated to the memory of Alfred Wegener, Professor Kirsch sets out his estimates and elaborates his subterranean-current theory of mountain-building and earth evolution.

Following a few preliminary pages devoted to a statement of the problem, he gives a 30-page review of what is now known of the physical and other conditions in the earth's interior. He believes with Joly that heat conduction from the interior toward the earth's surface is too slow to prevent an occasional partial melting of the base of the solidified shell, or Zwischenschicht. He estimates, further, that one of these periods of subterranean overheating ought to occur about as often as, in Professor Stille's opinion, a "revolution" has occurred (p. 25).

In a second section of comparable length to the one just mentioned, Professor Kirsch reviews the major topographic features of the earth, both above and below sea-level, and discusses at some length the Wegenerian shiftings that these features seem to him to have experienced. In a third section, pp. 72–139, he discusses the physical hypotheses needed to account for continental migration, polar wandering, ice ages, and other interesting phenomena to which he believes our Earth has been subject in the past. An equation-crowded chapter on magma currents is submitted to prove that they furnish the desired explanation.

There are, finally, a short supplement on sun, moon, and stars; a few pages of summary and conclusions; and an index.

In preparing this review, I am not inspired by any desire to pass upon the correctness of Professor Kirsch's physics, a matter about which I am not even conscious of having an opinion; nor do I wish to argue that because Professor Kirsch believes in continental drift, we geologists who may have doubted its existence should hasten to become converts. It seems quite possible, on the other hand, that Professor Kirsch, like Wegener himself, may have been unduly influenced by the number and apparent weight of the geological arguments advanced by Wegener in support of his theory. Perhaps Wegener was guilty of adopting geological hypotheses as proved that a more critical examination will show are not even likely; perhaps many of his supposed geological facts are errors. If so, we who are primarily geologists should be better able to judge of such matters than a physicist, such as Professor Kirsch.

To a very great extent, however, the geologists who have discussed the Wegener hypothesis have done so, not upon the basis of the adequacy or inadequacy of Wegener's geological arguments, but upon the inadequacy of his geophysical concepts. This procedure seems dangerous and likely even to become ridiculous. If Professor Kirsch knows no physical fact about the earth's interior that is inconsistent with continental drift, is it likely that I should? And if it is argued that Professor Kirsch may be exceptional, how about Professor Wegener himself? Or Professor Gutenberg, whose theory of "continental flow" is presented merely as a slight modification of Wegener's theory of "continental drift"? The time may be rapidly approaching, or may even be here now, when any geologist who knows some geophysical fact inconsistent with continental drift will be well advised to forget it and learn some new fact to take its place.

MEASUREMENT OF GEOLOGIC TIME, BY ALFRED C. LANE *ET AL.*

REVIEW BY ROGER C. WELLS[1]
Washington, D.C.

Report of the Committee on the Measurement of Geologic Time, 1937–1938. Alfred C. Lane, chairman, John Putnam Marble, vice-chairman. National Research Council Meeting of the Division of Geology and Geography, Washington, D. C., April 30, 1938. Mimeographed, 123 pp.

This report deals with recent progress in the measurement of geologic time. Following a general report of the committee there are twelve detailed reports, or exhibits, including an annotated bibliography of the subject. The chief methods considered are those based on atomic disintegration, but, whereas the problem formerly dealt with certain "elements" and their end products, it now has been broadened (or narrowed) to a consideration of the particular isotopes of the different elements that are known to be involved in the changes. The main results reported relate to improvements in apparatus and the preparation of new radium and thorium standards; they also relate to the more accurate determination of the different radioactive elements, their rates of disintegration, and the final products of disintegration. Both chemical and physical methods are employed. Numerous measurements on materials from many sources have been made from which tentative conclusions as to geologic age can be drawn, but it is still too early to attempt any extensive revision of the absolute geologic time scale now in general use. Results of the helium method, however, are in general lower than those obtained by the lead method.

[1] Chief chemist, U. S. Geological Survey. Manuscript received, January 27, 1939.

RECENT PUBLICATIONS

ARKANSAS

**Discussion of Petroleum Development in Arkansas, 1937–1938.* Prepared by the Arkansas Board of Conservation, El Dorado (January 1, 1939). Field activities; estimate of money invested; production; reserves; conservation; controlled production; production cost; *et cetera.* 73 pp., 4 photos, 3 geologic sections, 4 maps, 9 charts, 11 tables. 6×9 inches. Paper cover.

CALIFORNIA

"Molluscan Faunas of the Domingine and Arroyo Hondo Formations of the California Eocene," by Harold E. Vokes. *Annals New York Acad. Sci.*, Vol. 38 (January 4, 1939). Pp. iii+246.

CANADA

*"The Black River Group in the Region between Montreal and Quebec," by Vladimir J. Okulitch, *Amer. Jour. Sci.*, Vol. 237, No. 2 (New Haven, Connecticut, February, 1939), pp. 81–93.

*"Devonian Fossil Zones in Wells from Southwestern Ontario," by Made-

leine A. Fritz. *Bull. Geol. Soc. America*, Vol. 50, No. 1 (New York, January 1, 1937), pp. 79–88; 3 figs., 1 table.

CHILE

*"Petroleum Prospects in Chile," by Horst Falke. *Petrol. Zeit.* (Berlin), Vol. 35, No. 1–2 (January 11, 1939), p. 10; 1 fig. In German.

EAST INDIES AND SPAIN

*"Statistical Studies on the Phylogeny of Some Foraminifera. Cycloclypeus and Lepidocyclina from Spain, Globorotalia from the East Indies," by. A. J. Cosijn. *Leidsche Geol. Mededeelingen*, Vol. 10, No. 1 (Leyden, Netherlands, 1938), pp. 1-61; 11 figs., 5 pls. In English.

*"A Second Species of Biplanispira from the Eocene of Borneo," by J. H. F. Umbgrove. *Ibid.*, pp. 82–9; 3 pls. In English.

*"Cenozoic Decapod Crustaceans of the Netherlands East Indies," by V. Van Straelen. *Ibid.*, pp. 90–103; 4 figs. In French.

FLORIDA

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GENERAL

**Atlantisheft I, Geologische Rundschau,* Vol. 30, Nos. 1–2 (Ferdinand Enke, Stuttgart, 1939), 240 pp. Special Atlantic number. Contents as follows.

"Geophysical Basis for the Drift Theory," by Kurt Wegener. Pp. 3–5. In German.

"Source of Energy of the Earth," by Bailey Willis. Pp. 6–7. In German.

"Problem of Continental Drift," by W. A. J. M. van Waterschoot van der Gracht. Pp. 8–9. In German.

"The 'Permanenzproblem' According to the Undation Theory," by R. W. van Bemmelen. Pp. 10–20; 3 figs. In German.

"Tectonics of Atlantic Basin," by Friedrich Nölke. Pp. 21–27. In German.

"Tectonics of Atlantic Ocean," by Richard A. Zonder. Pp. 28–51; 1 fig. In German.

"Origin of Vulcanic Energy and Development of the Sial," by A Rittmann. Pp. 52–60. In German.

"Upper Cretaceous Alkaline Magmas on the Atlantic Border of Africa," by E. Krenkel. Pp. 61–63. In German.

"Stratigraphic and Faunal Basis for the Geological History of the South Atlantic Region," by H. Gerth. Pp. 64–79; 2 figs. In German.

"Data on the 'Werdegang' of the South Atlantic Region," by E. Hennig. Pp. 80–85. In German.

"Land Fauna and the Atlantis Problem," by F. von Huene. Pp. 86–88. In German.

"The Atlantis Problem in the Light of the Discoveries in the Quaternary," by Hellmut de Terra. Pp. 89–94. In German.

"Paleontology and the Drift Hypothesis," by E. H. Egmont Kummerow. Pp. 95–99. In German.

"Areal Types and the Atlantis Problem," by Otto Wittmann. Pp. 100–11. In German.

"Geographical Objections to the Wegnerian Theory of Continental Shifting," by Walter Behrmann. Pp. 112–20; 1 fig. In German.

"Sketch of Morphologic Details of the Ocean Floor by Echo Sounding," by A. Defant. Pp. 121–31; 8 figs., 1 table. In German.

"General Systematic Arrangement of the Ocean Depths," by Georg Wüst. Pp. 132–37; 1 fig. In German.

"The Origin of the Atlantic-Arctic Ocean," by Alex. L. du Toit. Pp. 138–47; 2 figs. In English.

"Argentinian 'Gondwaniden,'" by H. Keidel. Pp. 148–240; 18 figs. In German. (To be continued.)

*"Gas Bubbles as Nuclei for 'Oölites,'" by Edwin B. Eckel. *Science*, Vol. 89, No. 2298 (New York, January 13, 1939), pp. 37–38.

*"Eddies in Mountain Structure," by Edward Battersby Bailey. *Quar. Jour. Geol. Soc. London*, Vol. 94, Pt. 4 (December 30, 1938), pp. 607–25; 11 figs.

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*"Pre-Cambrian and Paleozoic Algae," by Carroll Lane Fenton and Mildred Adams Fenton. *Bull. Geol. Soc. America*, Vol. 50, No. 1 (New York, January 1, 1939), pp. 89–126; 9 figs., 11 pls.

GEOPHYSICS

*"Bibliography of Seismology," by Ernest A. Hodgson. No. 19, Items 4021–4138 (July, August, September, 1938), pp. 385–403. Canada Dept. Mines and Resources, Dominion Observatory, Ottawa. Paper. 9×11.5 inches. Price, $0.25.

*"Electrical Methods in Geophysical Exploration," by H. M. Evjen. *Geologie en Mijnbouw* (Geology and Mining), Vol. 1, No. 1, New Ser. (Leyden, Netherlands, January, 1939), pp. 2–8. In English. This brief article is in the new series of the official news journal of the Bureau of Geology and Mines for the Netherlands and Colonies, edited by L. U. deSitter, Rijksmuseum van Geologie, Leiden.

GREAT BRITAIN

**The British Rhaetic Flora*, by Thomas Maxwell Harris. 84 pp., 26 figs., 5 pls. Approx. 5.5×8.5 inches. Cloth. British Museum (Natural History), London (1938). Price, 7 s. 6 d.

JAPAN

"Distribution and Classification of Petroliferous Lands of Japan," by J. Omura. *Jour. Fuel Sec. Japan*, Vol. 15 (1936), pp. 1063–69. Position and importance of early Tertiary oil-bearing beds. Ref. *Japan Jour. Geol. Geogr.*, Vol. 15, No. 14 (1938).

KANSAS-MISSOURI-ILLINOIS

*"Forest City Area Correlated with Adjacent Territory," by H. G. Hotchkiss. *Oil and Gas Jour.*, Vol. 37, No. 37 (January 26, 1939, annual re-

view number), pp. 61–62. Contains geologic cross section of Forest City Basin in Kansas-Missouri; compared with Illinois basin.

LOUISIANA

*"Louisiana Sparta-Wilcox Well Extends Play East," by Neil Williams. *Oil and Gas Jour.*, Vol. 37, No. 37 (Tulsa, January 26, 1939, annual review number), pp. 59–60, 66. Contains sketch map of trend in Texas, Louisiana, and Mississippi; also Tertiary correlation chart of Texas and Louisiana.

*"Geology of Iberville and Ascension Parishes," by Henry V. Howe, Richard Joel Russell, Fred B. Kniffen, James H. McGuirt, and Stanley M. McDonald. *Louisiana Geol. Survey Bull. 13* (New Orleans, August, 1938). 223 pp., frontispiece, 23 figs., 1 pl., location map. 6×9 inches. Paper covers.

MEXICO

*"Some Types of Bedding in the Colorado River Delta," by Edwin D. McKee. *Jour. Geol.*, Vol. 47, No. 1 (Chicago, January–February, 1939), pp. 64–81; 5 figs., 2 pls.

*"Upper Jurassic Ammonites from Mexico," by Ralph W. Imlay. *Bull. Geol. Soc. America*, Vol. 50, No. 1 (New York, January 1, 1939), pp. 1–78; 7 figs., 10 tables, 18 pls.

MISSOURI

"Spirit Leveling in Northwest Missouri." *U. S. Geol. Survey Bull. 898-D*, Part 4 (1939). In coöperation with the Missouri Geological Survey (Rolla). May be obtained from Missouri Geological Survey. Price, $0.30.

NEBRASKA

*"The Redfield Anticline of Nebraska and Iowa," by G. E. Condra and E. C. Reed. *Nebraska Geol. Survey Paper 12* (December 1938). 19 pp., 1 fig. including a key map and two geologic sections.

NEW MEXICO

"Geology and Shallow-Water Resources of the Roswell Artesian Basin, New Mexico," by Arthur M. Morgan. Investigation in coöperation with the State Engineer of New Mexico. Report to be published in *13th Bien. Rept. of State Engineer* (Santa Fe); prior to publication, report may be consulted in offices of U. S. Geological Survey, Washington, D. C., and Albuquerque, New Mexico; and office of State Engineer, Santa Fe.

NEW ZEALAND

*"The Fauna of the Baton River Beds (Devonian), New Zealand," by Jack Shirley. *Quar. Jour. Geol. Soc. London*, Vol. 94, Pt. 4 (December 30, 1938), pp. 459–506; 5 pls.

TEXAS

*"Geology and Economic Significance of Barbers Hill Salt Dome," by Michel T. Halbouty. *World Petrol.*, Vol. 10, No. 1 (New York, January, 1939), pp. 40–55; 23 illus., 2 tables.

*"Eola Discovery Shows Multiple Sand Possibilities of Sparta-Wilcox Trend," by John D. Dodd and Frank C. Roper. *Oil Weekly*, Vol. 92, No. 9 (Houston, February 6, 1939), pp. 15–20; 4 figs.

ASSOCIATION DIVISION OF PALEONTOLOGY AND MINERALOGY

**Journal of Sedimentary Petrology* (Tulsa, Oklahoma), Vol. 8, No. 3 (December, 1938).

"Original Structures in Colorado River Flood Deposits of Grand Canyon," by Edwin D. McKee

"Size Frequency Distributions of Sediments and the Normal Phi Curve," by W. C. Krumbein

"Occurrence and Origin of Certain Limonite Concretions," by Robert L. Bates

"Correlation by Means of Bentonites," by C. V. Dorrell

"Rapid Method of Mechanical Analysis of Sands," by K. O. Emery

**Journal of Paleontology* (Tulsa, Oklahoma), Vol. 13, No. 1 (January, 1939).

"Siliceous Sponges from Mississippian and Devonian Strata of the Penn-York Embayment," by Kenneth E. Caster

"Revised Nomenclature for Some Nuculid Pelecypods," by Hubert G. Schenck

"A Preliminary Review of Certain Families of Diptera from the Florissant Miocene Beds, II," by Maurice T. James

"Pneumatocysts on *Monograptus* (Linograptus) *phillipsi multiramosus*," by Charles E. Decker

"Devonian Rugose Corals from the Traverse Beds of Michigan," by Laurence L. Sloss

"An Ordovician *Zitteloceras* from Wisconsin," by Vincent E. McKelvey

"Aturias from the Eocene of Panama," by A. K. Miller and W. M. Furnish

"An *Aturia* from the Northwest Division of Western Australia," by A. K. Miller and Irene Crespin

"Inadunate Crinoids of the Mississippian—*Zeacrinus*," by A. H. Sutton and Wallace W. Hagan

"Fossil Mollusks Preserved as Clay Replacements, near Pontotoc, Mississippi," by Lloyd William Stephenson

"*Turritella kellumi*, New Name for *Turritella subtilis* Stephenson," by Lloyd William Stephenson

"*Campanile greenellum*, a New Species from the Early Eocene of California," by G. Dallas Hanna and Leo George Hertlein

"*Helicoprion* in the Anthracolithic (Late Paleozoic) of Nevada and California, and Its Stratigraphic Significance," by Harry E. Wheeler

"Succession of Late Cambrian Faunas in the Northern Hemisphere," by B. F. Howell and Christina Lochman

"Suggestions Regarding the Taxonomy and Nomenclature of Cretaceous and Tertiary Plants," by Roy Graham

"Structure of the Vertebral Column in *Eusthenopteron foordi* Whiteaves," by William K. Gregory, Helen Rockwell, and F. Gaynor Evans

"Significance of Tertiary Mammalian Faunas in Holarctic Correlation with Special Reference to the Pliocene in California," by R. A. Stirton

"Certain Possibilities in the Field Study of Vertebrate Fossils," by John Clark

"Status of the Oligocene Insectivore Genus *Metacodon*," by John Clark

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 3 (MARCH, 1939), PP 356-435

THE ASSOCIATION ROUND TABLE

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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(Continued on page 460)

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FINANCIAL STATEMENT, 1938

To the Executive Committee,
The American Association of Petroleum Geologists,
Tulsa, Oklahoma.

DEAR SIRS:

We have made an examination of the accounting records of The American Association of Petroleum Geologists for the year ended December 31, 1938, and now submit our report thereon, together with the following statements:

Exhibit

A Statement of Financial Condition at December 31, 1938
B Statement of Income for the year ended December 31, 1938

Schedule

*1 Investments at December 31, 1938
2 Statement of Income from Publications for the year ended December 31, 1938
3 Statement of General and Administrative Expenses for the year ended December 31, 1938

In connection with the examination, we examined or tested the accounting records of the Association and other supporting evidence and obtained information and explanations from employees of the Association. We also made a general review of the accounting methods and of the operating and income accounts for the year, but we did not make a detailed audit of the transactions.

Demand Deposits were reconciled to certificates received directly from the depositories. Reserve of $817.35, provided for doubtful accounts receivable, appears adequate. In accordance with resolution adopted by the Executive Committee and consistent with the preceding year, publications on hand as shown by the records were priced at appraised values and a reserve provided for excessive quantities and old numbers; we made extensive tests of quantities and computations. Investments are stated at the lower of cost or market as compared with cost in prior years; the excess of cost over the lower of cost or market at December 31, 1938, of $5,718.43 was charged to Income. Confirmation of Certificates of Securities in the custody of The New York Trust Company at December 31, 1938, was received directly from the custodian.

In our opinion, based on such examination and subject to the comments in the preceding paragraph, the accompanying Statement of Financial Condition and related Statement of Income, supplemented by the Schedules, fairly present the financial position of the Association at December 31, 1938, and the results of its operations for the year ended that date.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
February 4, 1939

* Schedule I is not here published.

EXHIBIT A

STATEMENT OF FINANCIAL CONDITION AT DECEMBER 31, 1938

ASSETS	General Fund	Publication Fund	Research Fund	Total
CURRENT ASSETS:				
Demand Deposits—				
The First National Bank and Trust Company, Tulsa, Oklahoma	$ 9,299.00	$ 4,396.81	$ 22.50	$13,718.31
National Bank of Commerce, Tulsa, Oklahoma	505.91	—	—	505.91
TOTAL CASH IN BANKS	$ 9,804.91	$ 4,396.81	$ 22.50	$14,224.22
Accounts Receivable—				
Membership Dues (*less* Reserve $510.00)	$ 511.00	$ —	—	$ 511.00
Advertising	735.72	—	—	735.72
Due from the New York Trust Company	410.17	153.75	—	563.92
Other Accounts Receivable (*less* Reserve $307.35)	556.19	252.95	—	809.14
TOTAL ACCOUNTS RECEIVABLE	$ 2,213.08	$ 406.70	$ —	$ 2,619.78
Accrued Interest Receivable (*less* Reserve $355.41)	$ 365.63	$ 49.10	$ 25.52	$ 440.25
Inventory of Publications—See Report	$32,359.92	$10,072.57	$ —	$42,432.49
Less: Reserve	21,712.30	—	—	21,712.30
NET VALUE OF PUBLICATIONS	$10,647.62	$10,072.57	$ —	$20,720.19
TOTAL CURRENT ASSETS	$23,031.24	$14,925.18	$ 48.02	$38,004.44
INVESTMENTS:				
At Lower of Cost or Market (Market Value $58,858.65)	$44,299.21	$11,421.53	$1,738.55	$57,459.29
FURNITURE AND FIXTURES	$ 3,957.16	$ —	$ —	$ 3,957.16
Less: Reserve for Depreciation	3,457.62	—	—	3,457.62
NET VALUE OF FURNITURE AND FIXTURES	$ 499.54	$ —	$ —	$ 499.54
PREPAID AND DEFERRED CHARGES	$ 414.33	$ —	$ —	$ 414.33
TOTAL ASSETS	$68,244.32	$26,346.71	$1,786.57	$96,377.60

LIABILITIES AND SURPLUS	General Fund	Publication Fund	Research Fund	Total
CURRENT LIABILITIES:				
Accounts Payable	$ 1,354.77	$ —	$ —	$ 1,354.77
Accrued Printer's Charges	355.97	—	—	355.97
TOTAL CURRENT LIABILITIES	$ 1,710.74	$ —	$ —	$ 1,710.74
DEFERRED INCOME:				
Memberships and Subscriptions—				
Active Memberships	$ 3,223.00	$ —	$ —	$ 3,223.00
Associate Memberships	644.00	—	—	644.00
Subscriptions to Bulletin	2,697.50	—	—	2,697.50
	$ 6,564.50	$ —	$ —	$ 6,564.50
Advertising	$ 557.50	$ —	$ —	$ 557.50
TOTAL DEFERRED INCOME	$ 7,122.00	$ —	$ —	$ 7,122.00
SURPLUS:				
Balance, December 31, 1937	$61,171.01	$26,770.51	$1,569.93	$89,511.45
Net Income—*Loss* for the year ended December 31, 1938 (Exhibit *B*)	*−1,759.43*	*−423.80*	216.64	*−1,966.59*
Balance, December 31, 1938	$59,411.58	$26,346.71	$1,786.57	$87,544.86
TOTAL LIABILITIES AND SURPLUS	$68,244.32	$26,346.71	$1,786.57	$96,377.60

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B

STATEMENT OF INCOME FOR THE YEAR ENDED DECEMBER 31, 1938

	Members	Annual Dues	General Fund	General Fund	Publication Fund	Publication Fund	Research Fund	Research Fund	Total	Total
OPERATING INCOME:										
Associate Membership—										
Less than Three Years	469	$ 6.00	$2,814.00		$ —		$ —		$2,814.00	
Three to Six Years	68	8.00	544.00		—		—		544.00	
Over Six Years	105	10.00	1,050.00	$ 4,408.00	—	$ —	—	—	1,050.00	$ 4,408.00
Active Membership	2,217	10.00		22,170.00		—		—		22,170.00
				$26,578.00		$ —		$ —		$26,578.00
Less: Transferred to "Income from Publications"										
Associate Membership	642	6.00	$3,852							
Active Membership	2,217	6.00	13,302							
	2,859			17,154.00		—		—		17,154.00
				$ 9,424.00		$ —		$ —		$ 9,424.00
Net Income from Publications (Schedule 2)				6,619.12		588.15		—		7,207.27
Convention Receipts (Net)				*−80.84*		—		—		*−80.84*
				$15,962.28		$ 588.15		$ —		$16,550.43
GENERAL AND ADMINISTRATIVE EXPENSES (Schedule 3)				14,345.79		20.72		—		14,366.51
NET OPERATING INCOME				$ 1,616.49		$ 567.43		$ —		$ 2,183.92
OTHER INCOME:										
Income from "Investments"			$1,901.26		$ 437.66		$ 74.14		$2,413.06	
Contributions Received			—		—		300.00		300.00	
Recovery of Accounts previously charged off			118.00		—		—		118.00	
Miscellaneous			228.10	2,247.36	—	437.66	—	374.14	228.10	3,059.16
INCOME BEFORE DEDUCTIONS				$ 3,863.85		$1,005.09		$374.14		$ 5,243.08
INCOME DEDUCTIONS:										
Net Loss on Sale of Investments			$ 484.22		$1,007.02		$ —		$1,491.24	
Excess of cost of Investments over lower of cost or market at December 31, 1938			5,139.06	5,623.28	421.87	1,428.89	157.50	157.50	5,718.43	7,209.67
NET INCOME—*LOSS*				*$−1,759.43*		*$−423.80*		$216.64		*$−1,966.59*

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 2

STATEMENT OF INCOME FROM PUBLICATIONS FOR THE YEAR ENDED DECEMBER 31, 1938

	General Fund		*Publication Fund*		*Total*	
OPERATING INCOME:						
Dues Transferred		$17,154.00		$ —		$17,154.00
Bulletin Subscriptions		4,376.96		—		4,376.96
Advertising		7,093.72		—		7,093.72
Sale of Bound Volumes and Special Publications—						
Bound Volumes of Bulletin	$ 2,533.93		$ —		$ 2,533.93	
Back Numbers of Bulletin	858.10		—		858.10	
Miocene Stratigraphy of California	—		368.00		368.00	
Problems of Petroleum Geology	639.88		—		639.88	
Comprehensive Index	115.04		—		115.04	
Geology of Natural Gas	—		616.38		616.38	
Geology of Tampico Region	—		172.67		172.67	
Gulf Coast Oil Fields	—		743.44		743.44	
Structural Evolution of Southern California	—		299.44		299.44	
Typical American Oil Fields, Volume II	439.52		—		439.52	
Other Publications	66.34	4,652.81	21.90	2,221.83	88.24	6,874.64
TOTAL OPERATING INCOME		$33,277.49		$2,221.83		$35,499.32
COSTS AND EXPENSES:						
Proportion of Manager's Salary	$ 3,000.00		$ —		$ 3,000.00	
Editorial Salaries	4,840.00		—		4,840.00	
Printing Bulletins	12,778.54		—		12,778.54	
Engraving	1,945.66		—		1,945.66	
Stencil Corrections and Mailing	229.54		—		229.54	
Bulletin Mailing and Express	962.08		—		962.08	
Copyright Fees	24.00		—		24.00	
Reprints	149.04		—		149.04	
Other Publications—Freight, Express and Postage	320.41		139.61		460.02	
Binding Volume XXI	491.10		—		491.10	
Binding Gulf Coast Oil Fields	—		348.09		348.09	
Miocene Stratigraphy of California—Printing and Other Costs	—		3,786.77		3,786.77	
Miscellaneous	10.59		—		10.59	
	$24,750.96		$4,274.47		$29,025.43	
Add: Inventory Decrease—*Increase*	1,907.41		*—2,640.79*		*−733.38*	
TOTAL COSTS AND EXPENSES		26,658.37		1,633.68		28,292.05
NET INCOME FROM PUBLICATIONS		$ 6,619.12		$ 588.15		$ 7,207.27

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 3

STATEMENT OF GENERAL AND ADMINISTRATIVE EXPENSES

FOR THE YEAR ENDED DECEMBER 31, 1938

GENERAL FUND:	
Proportion of Manager's Salary	$ 2,840.00
Clerical Salaries	5,762.62
Office Rent	1,500.00
Postage	1,675.30
Office Supplies and Expenses	448.73
Printing and Stationery	408.05
Telephone and Telegraph	249.51
Investment Counsel	400.00
Audit Expense	300.00
Freight and Express	128.03
Insurance	179.28
Bad Debts	408.76
Miscellaneous	360.29
Depreciation of Furniture and Fixtures	388.03
	$15,048.60
Less: Expenses charged to Society of Economic Paleontologists and Mineralogists	702.81
	$14,345.79
PUBLICATION FUND:	
Bad Debts	$ 7.19
Miscellaneous	13.53
	$ 20.72
TOTAL GENERAL ADMINISTRATIVE EXPENSES	$14,366.51

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

FINANCIAL STATEMENT, DIVISION OF PALEONTOLOGY AND MINERALOGY, 1938

To the Council,
Society of Economic Paleontologists
and Mineralogists,
Tulsa, Oklahoma.

DEAR SIRS:

We have made an examination of the accounting records of the Society of Economic Paleontologists and Mineralogists for the year ended December 31, 1938, and now submit our report thereon, together with the following statements:

Exhibit
A Statement of Financial Condition at December 31, 1938
B Statement of Income for the year ended December 31, 1938

Schedule
1 Statement of Receipts and Disbursements for the year ended December 31, 1938

In connection with our examination, we examined or tested the accounting records of the Society and other supporting evidence and obtained information and explanations from employees of the Society, but we did not make a detailed audit of the transactions. In our opinion, the accounting records are neither adequate nor do they provide for sufficient classification of expenses. Our recommendations with respect to suggested changes in the accounting records have been discussed with J. P. D. Hull, business manager of the Society.

Demand and Savings Deposits were reconciled to certificates received directly from the depositories.

Inventory of Publications represents approximately 27,000 Journals (exclusive of Journals in excess of complete sets for issues prior to 1938) as shown by the records, including certain issues printed at the expense of the Paleontological Society for the years 1935 to 1938, inclusive, stated at appraised values of fifty cents each for Journals printed prior to 1938 or cost to either the Society of Economic Paleontologists and Mineralogists or the Paleontological Society for Journals printed in 1938. We made extensive tests of quantities and computations.

Effective April 1, 1938, the Society changed its schedule of membership dues to include publications as follows:

Membership with—	
Journal of Paleontology	$6.00
Journal of Sedimentary Petrology	3.00
Journals of Paleontology and Sedimentary Petrology	8.00

Memberships with the Journal of Sedimentary Petrology, paid prior to April 1, 1938, will be given a credit of $1.00 each on 1939 dues.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
February 7, 1939

EXHIBIT A
STATEMENT OF FINANCIAL CONDITION
AT DECEMBER 31, 1938

ASSETS

CURRENT ASSETS		
Demand Deposits—		
The First National Bank and Trust Company, Tulsa, Oklahoma	$ 3,182.21	
National Bank of Commerce, Tulsa, Oklahoma	87.67	$ 3,269.88
Savings Deposit—		
The First National Bank and Trust Company, Tulsa, Oklahoma		1,027.61
Accounts Receivable—		
Printed Matter	$ 115.35	
Advertising	110.00	
Other Accounts Receivable	30.38	255.73
Inventory of Publications (Quantities and Values determined by the Management)		13,917.43
TOTAL CURRENT ASSETS		$18,470.65
FURNITURE AND FIXTURES	$ 482.60	
Less: Reserve for Depreciation	47.68	434.92
TOTAL ASSETS		$18,905.57

LIABILITIES AND SURPLUS

CURRENT LIABILITIES:		
Accounts Payable		$ 292.06
DEFERRED INCOME:		
Subscriptions to Journals	$ 1,222.27	
Membership Dues for 1939 (including $1.00 for each membership with Journal of Sedimentary Petrology paid prior to April 1, 1938)	629.00	1,851.27
SURPLUS:		
Balance, December 31, 1937	$16,153.34	
Net Income for the year ended December 31, 1938 (Exhibit B)	608.90	
Balance, December 31, 1938		16,762.24
CONTINGENT LIABILITIES:		
The Business Manager of the Society has certified to us that all known liabilities were recorded in the accounts at December 31, 1938		
		$18,905.57

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B

STATEMENT OF INCOME FOR THE YEAR ENDED DECEMBER 31, 1938

OPERATING INCOME:			
Dues and Subscriptions—			
Membership Dues		$ 388.00	
Journal of Paleontology		3,051.49	
Journal of Sedimentary Petrology		998.11	
		$4,437.60	
Sale of Back Numbers—			
Journal of Paleontology	$1,804.55		
Journal of Sedimentary Petrology	537.00	2,341.55	
Advertising		477.33	
Other Operating Income		203.37	$7,459.85
COSTS AND EXPENSES			
Printing Expenses—			
Journal of Paleontology	$2,436.13		
Journal of Sedimentary Petrology	764.90	$3,201.03	
Binding and Plates		93.80	
Clerical Salaries		1,165.00	
Office Supplies and Expenses		316.54	
Postage and Mailing		496.38	
Freight and Express		185.93	
Rent		300.00	
Audit Expense		50.00	
Refunds on Subscriptions		54.53	
Depreciation		47.68	
Other Costs and Expenses		172.70	
Bad Debts		64.00	
		$6,147.59	
Decrease in Inventory of Publications		723.60	6,871.19
			$ 588.66
OTHER INCOME:			
Interest on Investments			20.24
NET INCOME			$ 608.90

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 1
STATEMENT OF RECEIPTS AND DISBURSEMENTS
FOR THE YEAR ENDED DECEMBER 31, 1938

Demand Deposits, December 31, 1937			$2,371.58
Receipts:			
Membership Dues and Subscriptions—			
Year 1938—			
Membership Dues	$ 254.00		
Journal of Paleontology	2,044.42		
Journal of Sedimentary Petrology	652.91	$2,951.33	
Year 1939—			
Membership Dues	$ 629.00		
Journal of Paleontology	892.26		
Journal of Sedimentary Petrology	306.11	1,827.37	
Year 1940—			
Journal of Paleontology	$ 11.80		
Journal of Sedimentary Petrology	9.10	20.90	
Year 1941—			
Journal of Sedimentary Petrology		3.00	
		$4,802.60	
Accounts Receivable		415.45	
Sale of Back Numbers—			
Journal of Paleontology	$1,757.30		
Journal of Sedimentary Petrology	493.70	2,251.00	
Advertising		367.33	
Sale of Plates		133.82	
Miscellaneous		39.17	8,009.37
			$10,380.95
Disbursements:			
Printing Expenses—			
Journal of Paleontology	$2,988.22		
Journal of Sedimentary Petrology	760.60	$3,748.82	
Binding and Plates		93.80	
Clerical Salaries		1,165.00	
Office Supplies and Expenses		361.96	
Postage and Mailing		496.38	
Freight and Express		185.28	
Refunds on Subscriptions		54.53	
Furniture and Fixtures		482.60	
Audit Expense		50.00	
Rent		300.00	
Miscellaneous		172.70	7,111.07
Demand Deposits, December 31, 1938			$3,269.88

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 3 (MARCH, 1939), PP. 368-435

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS MEMBERSHIP LIST[1]

MARCH 6, 1939

HONORARY MEMBERS

The executive committee may from time to time elect as honorary members persons who have contributed distinguished service to the cause of petroleum geology. Honorary members shall not be required to pay dues.—*Sec. 6, Article III, of the Constitution.*

LIFE MEMBERS

The executive committee may grant life membership to members who have paid their dues and are otherwise qualified.—*Sec. 2, Article III, of the Constitution.*

On the payment of two hundred dollars ($200.00) any member in good standing shall be declared a life member and thereafter shall not be required to pay annual dues. —*Sec. 2, Article I, of the By-Laws.*

MEMBERS

Any person engaged in the work of petroleum geology or in research pertaining to petroleum geology or technology is eligible to active membership, provided he is a graduate of an institution of collegiate standing, in which institution he has done his major work in geology, or in sciences fundamental to petroleum geology, and in addition has had the equivalent of three years' experience in petroleum geology or in the application of these other sciences to petroleum geology or to research in petroleum geology or technology; and provided further that in the case of an applicant for membership who has not had the required collegiate or university training, but whose standing in the profession is well recognized, he shall be admitted to membership when his application shall have been favorably and unanimously acted upon by the executive committee, and provided further that these requirements shall not be construed to exclude teachers and research workers in recognized institutions whose work is of such character as in the opinion of the executive committee shall qualify them for membership.

Active members alone shall be known as members.—*Sec. 1, Article III, of the Constitution.*

ASSOCIATES

Any person having completed as much as thirty hours of geology (an hour shall here be interpreted as meaning as much as sixteen recitation or lecture periods of one hour each, or the equivalent in laboratory) in a reputable institution of collegiate or university standing, or who has done field work equivalent to this, is eligible to associate membership, provided at the time of his application for membership he shall be engaged in geological studies in an institution of collegiate or university standing, or shall be engaged in petroleum geology; and any person who is a graduate of an institution of collegiate standing, in which he has done his major work in sciences fundamental to petroleum geology or petroleum technology, and who has had the equivalent of one year's experience in the application of his science to the study of petroleum geology, shall be eligible to associate membership, provided at the time of his application for membership he shall be engaged in investigations in the broader subject of petroleum geology and technology.

Associate members shall be known as associates.

Associates shall enjoy all the privileges of membership in the Association, save that they shall not hold office, sign applications for membership, or vote; neither shall they have the privilege of advertising their affiliation with the Association in professional cards or professional reports or otherwise.—*Sec. 3, Article III, of the Constitution.*

[1] This list is published for the use of the members and for the information of all who wish to refer to the professional and business affiliations of the members. It is not a mailing address list and it is not intended to be used for circularizing or soliciting purposes.

HONORARY MEMBERS

Campbell, Marius R., 779 Fourth Ave., N., St. Petersburg, Fla.
Darton, N. H., U. S. Geological Survey, Washington, D. C.
Decker, Charles E., 508 Chautauqua Ave., Norman, Okla.
**Dumble, E. T.
Goodrich, Harold B., 1628 S. Cincinnati, Tulsa, Okla.
Harris, Gilbert D., Dept. of Geology, Cornell University, Ithaca, N. Y.
Hill, Robert T., c/o Dallas News, Dallas, Tex.
Lawson, Andrew C., University of California, Berkeley, Calif.
Mendenhall, Walter C., U. S. Geological Survey, Washington, D. C.
Orcutt, W. W., Rancho Sombra del Roble, Canoga Park, Calif.
Ordoñez, Ezequiel, Abraham Gonzales 79, Mexico City, Mexico
**Salisbury, R. D.
Schuchert, Charles, Yale University, New Haven, Conn.
Smith, George Otis, Box 308, Skowhegan, Me.
Stille, Hans, Geological Institute, University of Berlin, Berlin, Germany
Taff, Joseph A., 628 Cowper St., Palo Alto, Calif.
**Udden, Johan August
Ulrich, E. O., National Museum, Washington, D. C.
van der Gracht, W.A.J.M., Staatstoezicht op de Mijnen, 95 Akerstraat, Heerlen, Netherlands
**von Hofer, Hans Hofrat
**White, David
**White, I. C.

(**Deceased)

COMPLETE LIST OF MEMBERS, ASSOCIATES, HONORARY MEMBERS, AND LIFE MEMBERS

Honorary	16
Life	3
Members	2,294
Associates	644
Total	2,957

EXPLANATION OF SYMBOLS

*Honorary member. † Life member. ‖ Associate. Members are not marked. The year refers to the date of election to membership.

‖Abbott, John L., Pritchard & Abbott, 1209 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. ... '27
‖Abell, George T., Tex-Mex Petr. Corp., Box 430, Midland, Tex. ... '29
Abernathy, G. E., State Geol. Survey of Kansas, Pittsburg, Kan. ... '38
Abraham, A. W., Richfield Oil Corp., Los Angeles, Calif. ... '30
‖Absher, K. B., 1121 Union Natl. Bank Bldg., Wichita, Kan. ... '25
Absher, William F., Cities Service Oil Co., Geol. Dept., Bartlesville, Okla. ... '20
Achning, Walter J., 923 Milam Bldg., San Antonio, Tex. ... '38
Ackers, A. L., Stanolind Oil & Gas Co., Box 1410, Fort Worth, Tex. ... '25
Ackley, Kenneth A., Carter Oil Co., Seminole, Okla. ... '38
Adams, Elmo W., Honolulu Oil Corp., 215 Market St., San Francisco, Calif. ... '30
Adams, Frank C., Gem Oil Co., 1506 Esperson Bldg., Houston, Tex. ... '27
Adams, John Emery, Standard Oil Co. of Texas, Drawer R, Midland, Tex. ... '29
‖Adams, Kilburn E., The Texas Co., Box 2420, Tulsa, Okla. ... '38
Adams, W. C., Deep Rock Oil Corp., 1012 Atlas Life Bldg., Tulsa, Okla. ... '24
Addison, Carl C., Pure Oil Co., 402 Second Natl. Bank Bldg., Saginaw, Mich. ... '30
Adkins, W. S., Shell Petr. Corp., Houston, Tex. ... '20
‖Adkisson, Albert, 2019 W. T. Waggoner Bldg., Fort Worth, Tex. ... '34
Adler, Joseph L., Independent Expl. Co., 2011 Esperson Bldg., Houston, Tex. ... '30
‖Agee, Flint H., 6115 Middleton, Huntington Park, Calif. ... '38
‖Agey, Charles S., Amerada Petr. Corp., Box 995, Wichita, Kan. ... '38

Aguerrevere, Pedro I., Servicio Técnico de Minería y Geología, Caracas, Venezuela, S.A. .... '24
Aguerrevere, Santiago E., Servicio Técnico de Minería y Geología, Caracas, Venezuela, S. A. .... '24
Aimer, James D., Arkansas Nat. Gas Corp., Drawer 1734, Shreveport, La. .... '26
Ainsworth, David, 146 S. Fountain Ave., Wichita, Kan. .... '23
Aitken, W. Ernest, consulting, Hondo, Colombia, S. A. .... '32
Albertson, Maurice M., Shell Petr. Corp., Box 2099, Houston, Tex. .... '20
Albrecht, Helmuth, Burbach-Kaliwerke Aktiengesellschaft, Kaiser-Otto-Ring 9, Magdeburg, Germany .... '32
Albritton, Claude C., Jr., Dept. of Geology, Southern Methodist Univ., Dallas, Tex. .... '39
Alcorn, A. H., Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex. .... '32
Aldrich, G. Frank, 410 Petroleum Bldg., Midland, Tex. .... '25
Alexander, C. I., Geol. Dept., Magnolia Petr. Co., Tyler, Tex. .... '27
||Alexander, Clyde W., Phillips Petr. Co., Box 491, El Dorado, Ark. .... '38
Allan, John Andrew, Univ. of Alberta, Edmonton, Alta., Canada .... '30
Allan, Thomas H., petroleum geologist, 921 Union Natl. Bank Bldg., Wichita, Kan. .... '24
Allen, Alton C., Rowan & Nichols Oil Co., 903 Trinity Life Bldg., Fort Worth, Tex. .... '35
Allen, Devere F., 3000 Sowers Court, Topeka, Kan. .... '29
Allen, Donald M., Signal Oil Co., 612 Orpheum Bldg., Wichita, Kan. .... '24
Allen, E. G., 3912 Amherst St., Dallas, Tex. .... '17
||Allen, Frank T., Gulf Research & Dev. Co., Box 2038, Pittsburgh, Pa. .... '39
||Allen, Harris Hayes, Phillips Petr. Co., Owensboro, Ky. .... '39
||Allen, Harry B., Dept. of Geology, Univ. of California, 405 Hilgard Ave., Los Angeles, Calif. .... '38
Allen, Stanley R., Humble Oil & Refg. Co., 256 Humble Bldg., Houston, Tex. .... '35
Allison, Archibald, Burma Oil Co., Ltd., Karachi, India .... '38
Allison, A. P., Sun Oil Co., Box 2657, Houston, Tex. .... '21
||Allon, Michael, Box 1031, Duncan, Okla. .... '37
||Alquist, Francis Nelson, 1212 W. Carpenter St., Midland, Mich. .... '38
||Alvarado, Benjamin, Ministerio de la Economia, Bogota, Colombia, S. A. .... '38
||Alvarez, Manuel, Jr., Administracion General del Petroleo Nacional, Colon 39, Mexico, D. F., Mex. .... '36
Ambrose, A. W., Cities Service Oil Co., Bartlesville, Okla. .... '19
Ames, Edward W., consulting, Box 921, Denver, Colo. .... '19
Anderson, Amil A., independent operator, 5424 Agnes Ave., N. Hollywood, Calif. .... '22
Anderson, Carl B., Gulf Refg. Co., Box 482, Mattoon, Ill. .... '19
Anderson, Carl C., U. S. Bureau of Mines, Box 2250, Amarillo, Tex. .... '32
Anderson, Frank M., 58 Hill Crest Rd., Berkeley, Calif. .... '24
Anderson, G. E., Dept. of Geology, Univ. of Oklahoma, Norman, Okla. .... '24
||Anderson, James B., Barnsdall Oil Co., Petroleum Securities Bldg., Los Angeles, Calif. .... '38
Anderson, John G., Judge Bros., 815 Chronicle Bldg., Houston, Tex. .... '21
Anderson, Ray Ball, Columbian Carbon Co., Box 1240, Charleston, W. Va. .... '24
||Anderson, Robert G., Forest Development Corp., Box 167, Abilene, Tex. .... '38
||Anderson, Tom A., Standard Oil Co. of La., Shreveport, La. .... '36
Anderson, W. D., Amerada Petr. Corp., Box 1366, Midland, Tex. .... '27
Andrau, E. W. K., consulting, Box 2408, Houston, Tex. .... '32
Andrews, Philip, Socony-Vacuum Oil Co., Apt. 246, Caracas, Venezuela, S. A. .... '25
Andrews, Thomas G., University of Alabama, University, Ala. .... '37
||Andrews, W. W., c/o W. L. Chaillot, Humble Bldg., Houston, Tex. .... '36
Angle, W. M., Standard Oil Co. of Kansas, 600 Esperson Bldg., Houston, Tex. .... '30
Apfel, Earl T., Syracuse Univ., Syracuse, N. Y. .... '29
Applin, Paul L., Cosden Petr. Corp. 1607 Electric Bldg., Fort Worth, Tex. .... '19
Archie, Gustave E., Shell Petr. Corp., Shell Bldg., Houston, Tex. .... '38
||Arellano, A. R. V., Cia Mex. de Pet. "El Aguila" S. A., Apt. 150, Tampico, Mex. .... '38
Argabrite, William Graeme, consultant, Box 33, Lewisburg, W. Va. .... '28
Arick, M. B., Lago Petr. Corp., Apartado 172, Maracaibo, Venezuela, S. A. .... '27
Armstrong, Earle N., Shamrock Oil & Gas Corp., Amarillo, Tex. .... '33
Armstrong, Harold K., consulting, 1002 Edison Bldg., Los Angeles, Calif. .... '27
Armstrong, J. M., Box 990, Midland, Tex. .... '18
Arnold, Emmett L., Box 124, La Feria, Tex. .... '27

Arnold, H. H., Jr., The Texas Co., Box 2420, Tulsa, Okla....................'27
Arnold, Henry C., British American Oil Prod. Co., 1406 Philtower Bldg., Tulsa, Okla....................'30
Arnold, Ralph, consulting, Subway Terminal Bldg., Los Angeles, Calif...........'18
Aronson, Sam M., Atlantic Refg. Co., 701 Magnolia Bldg., Dallas, Tex..........'24
||Artusy, Ray, Univ. of Texas, Austin, Tex....................'38
Ashauer, Hans F., The Texas Co., 117 Jefferson St., Coalinga, Calif..............'37
Ashley, Burton E., The Texas Co., Box 1801, Wichita, Kan....................'37
Athy, Lawrence F., Geophysical Div., Continental Oil Co., Ponca City, Okla.....'26
Atwater, Gordon I., c/o William Helis, 912 Whitney Bldg., New Orleans, La.....'38
Atwill, E. R., Union Oil Co. of Calif., 617 W. Seventh St., Los Angeles, Calif.....'31
Augenthaler, Robert L., The California Co., 1500 Petroleum Bldg., Houston, Tex..'38
Aurand, Harry A., consulting, 1350 Bellaire St., Denver, Colo..................'26
Aurin, Fritz L., Southland Royalty Co., 1605 Trinity Life Bldg., Fort Worth, Tex..'17
Autry, Vernon E., Fain-McGaha Oil Corp., 607 Hamilton Bldg., Wichita Falls, Tex....................'26
Avery, C. Dwight, U. S. Geological Survey, 3240 Interior Bldg., Washington, D. C..'28
Ayers, Floyd M., N. N. G. P. M., Babo, New Guinea....................'30

||Baak, Jan A., Ned. Nieuw Guinea Petrol Mij., Babo, New Guinea, Netherlands Indies....................'37
||Babin, Logan H., The Texas Co., Houma, La....................'38
Bace, A. C., Stanolind Oil & Gas Co., Philcade Bldg., Tulsa, Okla...............'24
||Back, Denys H., Apt. 36, River Oaks Gardens, Houston, Tex....................'37
Bacon, Charles S., Jr., Geol. Dept., Texas A. & M. College, College Station, Tex..'29
Baddley, E. R., The Texas Co., Bakersfield, Calif....................'36
Baden, Martin W., Box 520, Winfield, Kan....................'21
Bader, G. E., Humble Oil & Refg. Co., 857 Humble Bldg., Houston, Tex.........'34
||Badoux, Heli, Iraq Petr. Co., Ltd., Box 15, Deir-ez-Zor, Syria.................'38
Bagg, Rufus M., Lawrence College, Appleton, Wis....................'27
Bailey, James P., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif....'31
||Bailey, Joe E. L., 1201 E. Eleventh St., Winfield, Kan....................'30
||Bailey, John J., Argo Oil Corp., Box 1814, Midland, Tex....................'37
Bailey, Thomas L., Shell Petr. Corp., Box 2099, Houston, Tex....................'24
Bailey, Willard F., Skelly Oil Co., 419 Ardis Bldg., Shreveport, La..............'35
Bain, H. Foster, Bureau of Mines, Manila, P. I....................'26
Baird, Chester A., Danish American Prospecting Co., Copenhagen, Denmark......'21
Baker, Arthur A., U. S. Geological Survey, Washington, D. C....................'30
Baker, Norval E., Iraq Petr. Co., Ltd., City Gate House, Finsbury Square, London, E. C. 2, England....................'27
Baker, Raymond F., The Texas Co., Geol. Dept., 135 E. Forty-second St., New York, N. Y....................'17
Baker, William A., Jr., 3218 Ewing St., Houston, Tex....................'24
Bakke, W. E., 710 W. Sixteenth St., Owensboro, Ky....................'28
Baldwin, E. B., Arkansas Fuel Oil Co., Box 283, Houston, Tex....................'29
Bale, Hubert E., 319 Colcord Bldg., Oklahoma City, Okla....................'24
Ball, Max W., Abasand Oils, Ltd., Edmonton, Alta., Canada....................'19
Ballard, James L., Tide Water Associated Oil Co., 323 Nixon Bldg., Corpus Christi, Tex....................'25
Ballard, William Norval, consulting, 1105 N. E. Twentieth St., Oklahoma City, Okla....................'29
Banks, Thomas R., Transwestern Oil Co., Box 88, San Antonio, Tex..............'27
||Banta, David A., 2413 Fourteenth St., Lubbock, Tex....................'38
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Richards, J. T.
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Lindeblad, E. E.
Maddox, Gerald C.
McCoy, Alex W.
Mills, R. van A.
Morgan D. M.
Mullinax, Jack D.
Parker, Everett C.
Prokesh, Hugh E.
Willis, S. Morse
PURCELL—Perkinson, Floyd
SAPULPA—MacKay, Hugh
SEMINOLE—Ackley, Kenneth A.
Nichols, Paul B.
Polk, Donald J.
Rau, Harold L.
SHAWNEE
Brown, Augustus Bart
Brown, Robert
Carpenter, Everett
Copass, Jack M.
Dawson, Edwin A.
Gahring, William R.
Girdler, Tom M., Jr.
Goodman, P. W.
Graham, W. L.
Hestbeck, Marion E.
Hill, V. G.
Hoyle Charles R.
Jenkins Harold D.
Kittredge, Frank R.
Lehman Roy P.
Meyer, Arthur M.
Muir, J. Lawrence
Quiett, Roy C.
Roberts, Gerald C.
Roberts, M. C.
Ruwwe, John W.
Veeder, John A.
Withers, F. Spencer
Wynn, Warren H.
SULPHUR—Fitts, John
TALIHINA—Zorichak, Joseph J.
TULSA—Adams, Kilburn E.
Adams, W. C.
Arnold, H. H., Jr.
Arnold, Henry C.
Bace, A. C.
Bartram, John G.
Bass, N. W.
Bates, R. P.
Bean, Ward C.
Beck, Elfred
Becker, Dwight L.
Becker, Herman Carroll
Beekly, Albert L.
Bernard, W. E.
Bloesch, Edward
Bohart, Philip H.
Borden, Joseph L.
Born, W. T.
Branson, E. R.
Brant, Ralph A.
Brown, Harry J.
Brown, Merritt H.
Buckstaff, Sherwood
Bullard, Edgar F.
Bush, Frederic A.
Butt, William H.
Carlson, Charles G.
Case, Leslie G.
Chevalier, Jerome A.
Clark, Frank Rinker
Clark, Howard
Clark, Joseph M.
Clark, L. W.
Coffin, R. Clare
Coryn, F. R.
Cram, Ira H.
Cullen, Ronald J.
Cumming, Alfred
Curran, Bernard E.
Davis, Leon V.
Davis, Sidney H.
Denison, A. R.
Devin, Fred A.
Dillard, W. Reese
Dille, Glenn Scott
Eckenwiler, Cleo W.
Edson, Fanny C.
Egan, J. A.
Eirich, Constance G.
Elson, William H.
Emrick, D. G.
Faust, L. Y.
Feagin, Barney, Jr.
Ferguson, John L.
Finley, F. C.
Fitzgerald, Paul E.
Floyd, Florin W.
Foley, Lyndon L.
Fosshage, E. W.
Galley, John E.
Gardner, James H.
Garrett, Robert E.
Gawthrop, R. M.
Gilmour, Andrew
Ginter, Roy L.
Goodrich, Harold B.
Graeber, Clyde P.
Green, Darsie A.
Green, William G.
Greene, Eva Hirdler
Griffith, Glenn R. V.
Hall, Dollie Radler
Hamilton, Robert G.
Harlton, Bruce H.
Hawkins, Glenn D.
Hengst, Jess H.
Henry, W. W.
Herald, Frank A.
Herald, J. M.
Hewett, Charles F.
Higginbotham, I. S.
Hoffman, Malvin G.
Hollingsworth, R. V.
Holmes, S. W.
Hood, Forrest W.
Hoover, James B.
Horkey, William E.
Hosterman, John F.
Howard, W. V.
Howell, J. V.
Hudson, Oscar M.
Hughes, Richard
Hull, J. P. D.
Hunt, Lenora May
Ingham, W. I.
Innes, Arland I.
Johns, Wendell S.
Johnson, Edward W.
Johnston, Leslie A.
Kauffman, James S.
Kennedy, Luther E.
Kiess, Myron C.
Kimball, Kent K.
King, Charles C.
Kirk, Kathleen
Kister, Herbert H.
Knappen, Russell S.
Kravis, Raymond F.
Kridler, George M.
Lamar, Lee C.
Lambert, Gerald S.
Lang, William J.
Larkin, J. J., Jr.
Larkin, Pierce
Lauer, A. W.
Leach, Thomas W.
Leatherock, Constance
Leiser, J. B.
Lester, O. C., Jr.
Levorsen, A. I.
Lilienborg, B. A.
Littlefield, Max S.
Lukert, Louis H.
Lyons, Paul L.
Markham, Edmond O.
Markley, Elmer A.
Matson, George C.
McCollum, Leonard F.
McCrary, E. W.
McCutchin, John A.

McEachin, W. D.
McGirl, J. N.
McIntyre, Paul J.
McMillen, Raymond F.
Merritt, John W.
Mitchell, Harold D.
Miller, Wendell Z.
Millikan, C. V.
Millison, Clark
Morero, Joseph E.
Morley, Harold T.
Mosburg, Lewis G.
Moses, Harold F.
Murphy, James K.
Murray, A. N.
Nedom, Henry A.
Nelimark, John H.
Neumann, L. Murray
Newman, Thomas F.
Newton, William W.
Nufer, D. C.
Oliphant, A. G.
Payne, C. Winthrop
Peabody, Harlan W.
Peaker, Don H.
Pishel, Max A.
Price, James A.
Price, Sylvan S.
Rae, Colin C.
Redfield, John S.
Reisher, Paul H.
Reynolds, Karl W.
Richards, Raymond
Riggs, Robert J.
Riter, Samuel W.
Roark, Edward L.
Roark, Louis
Roark, R. B.
Ross, Charles M
Rowley, A. B.
Rutledge, R. B.
Ryniker, Charles S.
Sackett, H. F.
Scott, H. M.
Scott, Vernon C.
Scudder, E. W.
Shea, E. F.
Sheldon, W. W.
Sherry, William J.
Shutt, Roscoe E.
Sidwell, Carroll V.
Simpson, Richard W., Jr.
Siverson, G. C.
Snow, D. R.
Solliday, A. L.
Stoner, O. E.
Strachan, Clyde G.
Stump, Mark Eugene
Tandy, J. Hiram
Tarr, Russell S.
Teis, Maurice R.
Templeton, James B.
Tillotson, Allen W.
Tipsword, Howard L.
Travis, Abe
Truex, Arthur F.
Tucker, M. B.
Tucker, Paul M.
Upp, Jerry E.
Vernon, Jess
Wagner, Carl D.
Wagner, Clyde L.
Wagoner, George E.
Wails, Elmer D.
Walker, Jules Hargis
Walker, Lucian H.
Wallace, P. A.
Wanenmacher, Joseph M.
Watkins, William A.
Watson, Joseph D.
Weatherby, B. B.
Weimer, Frank G.
Welch, Virgil H.
Wells, Samuel W.
Westby, Gerald H.
White, Kirk S.
White, Luther H.
Willson, Kenneth M.
Wilshire, L. M.
Wilson, Walter B.
Wing, Robert B.
Wood, Robert H.
Wood, Virgil O.
Woods, Sam H.
Wright, A. P.
Wright, Harry F.
Wyman, Everett A.
Zoller, Lawrence J.
WATONGA—Kolm, Paul H.

OREGON

PORTLAND—Hawkins, Arthur L.
Williston, Samuel H.

PENNSYLVANIA

ALLISON PARK
Brankstone, Hugh R.
BRADFORD—Eckert, Frank E.
Fralich, Charles E.
BUTLER—Shaffer, John J.
DELMONT
Zimmerman, James Z.
EASTON—Ward, Freeman
GERMANTOWN—Giles, John M.
HARRISBURG—Dickey, Parke A.
OIL CITY
Montgomery, James G.
Secor, Donald T.
Siefert, Wilbur H.
PHILADELPHIA
Dickerson, Roy E.
Ellis, George L.
Weeks, Herbert J.
PITTSBURGH—Allen, Frank T.
Bardeen, Thomas
Davis, Ralph E.
Dresbach, C. H.
Durham, James H.
Eckhardt, E. A.
Fettke, Charles R.
Foster, Alden W.
Galey, John Taylor
Gealy, Wendell B.
Gemmell, Howard F.
Gibbs, Harley S.
Goodman, John V.
Gulley, M. Gordon
Hastings, Wynne K.
Heald, K. C.
Heggblom, J. Conrad
Hopkins, Richard H.
Huntley, Louis G.
Kerbow, Russell B.
Lang, Ralph H.
Melchoir, Louis F.
Mortlock, Frank O.
Myers, Clay Kenton
Myers, Thurman H.
Nettleton, L. L.
Newlon, J. H.
Rand, Wendell P.
Robinson, J. French
Ross, Ralph B.
Schillhahn, E. O.
Sherrill, Richard E.
Somers R. E.
Stephenson, Elizabeth
Tolmachoff, I. P.
Vance, W. R.
Watson, George R.
Wilcox, Quentin L.
Wylie, James R., Jr.
PORT ALLEGANY—Gaddess, Jack
Walters, Mason G.
STATE COLLEGE
Pirson, Sylvain J.
WAYNE—Mahoney, Roger S.

SOUTH DAKOTA

EDGEMONT—Lee, Clarence L.
RAPID CITY—Tullis, Edward L.
VERMILION—Rothrock, E. P.

TENNESSEE

COLUMBIA—Butters, Roy M.
KNOXVILLE—Hall, George M.
NASHVILLE—Born, Kendall E.
Glenn, L. C.
Wilson, Charles W., Jr.
SPRINGFIELD
Preston, J. Basil

TEXAS

ABILENE
Anderson, Robert G.
Boehms, Eugene F.
Byram, John P.
Coryell, Lewis S.
Haase, Fred M.
Hall, Ellis A.
Keeler, Edgar A.
Maxwell, Riley G.
Merry, Edward T.
Nowels, Kenneth B.
Perini, Vincent C.
Warner, Ralph E.
Weaver, George A.
Womack ,Brame
Word, Charles F.
Wright, Ray H.
ALBANY—Stasney, H. R.
ALICE—Franks, Robert M.
Short, Richard T.
Watson, Robert N.
ALLEYTON
Griffith, Cunningham L.
ALVIN—Durkee, Robert R.
AMARILLO
Anderson, Carl C.
Armstrong, Earle N.
Carter, G. R.
Craig, T. C.
Fenn, Ivan J.
Hagy, Lawrence R.
Hemsell, Clenon C.
Henderson, W. D.
Hughes, C. Don
Kautz, Archie R.
Peterson, Clarence J.
Rogatz, Henry
Rumsey, Edward W.
Rusk, William W.
Terrill, J. V.
Thompson, James D.
ARLINGTON—Lynch, S. A.
ATLANTA—McGlothlin, Tom
AUSTIN—Artusy, Ray
Bramlette, William Allen
Bullard, Fred M.
Bybee, Hal P.
Byram, R. W.
Cuyler, Robert H.
Damon, H. Gordon
Foster, C. V.
Fouts, John M., Jr.
Frost, Jay Miles, III
George, W. O.
Hoyt, William V.
Jackson, J. R., Jr.
McCoy, George Y.
Musselman, George Abraham
Plummer, F. B.
Power, Harry H.
Sellards, E. H.
Sparenberg, G. R.
Stenzel, Henryk B.
Whitney, F. L.
Winkler, Hans
BASTROP—McCallum, Henry D.
BEEVILLE
Barber, Clifford F.
Barnett, D. G.
Gully, Philip D.

Hancock, J. M.
Meltzer, Lee Hillard
Miller, David M.
Powell, Ezra H.
Pyeatt, Lloyd M.
Senseman, R. B.
Shayes, Fred P.
Swiger, Rual B.
BEAUMONT
Bartlett, C. Lothrop
Braugh, Donald D.
Claypool, C. B.
Cook, E. E.
Denton, Harold
Durgan, Herbert L.
Jamison, Maurine H.
Jamison, Paul H., Jr.
Justice, Philip S.
La Touche, John D.
Pack, R. W.
Rose, Harrison W.
BIG SPRING—Barnes, Chester F.
BORGER—Van Sant, John S.
BRENHAM
Ferguson, W. B.
BROWNFIELD
Evans, David Morgan
BROWNSVILLE
Wallis, William E.
CAMERON—Robinson, B. F.
CLARKWOOD
Myers, Marshall W.
COLEMAN—Cheney, M. G.
COLLEGE STATION
Bacon, Charles S., Jr.
Burt, Frederick A.
Gross, Henry Emmett
Turner, Francis Earl
Vance, Harold
CONROE—Gunn, James E.
CORSICANA
McGlothlin, William C.
CORPUS CHRISTI
Ballard, James L.
Beatty, Robert M.
Beilharz, Carl F.
Benish, Robert L.
Benson, Dale L.
Bocock, Oscar L.
Bong, Carl P.
Buck, Cleo Eugene
Cardwell, William Henry
Conley, J. N.
Cox, Thomas S.
Cunningham, Carleton J.
Day, Willard L.
Eagen, W. K.
Ferguson, M. L.
Fisher, Dunbar A.
Getzendaner, A. E.
Gierhart, Guy B.
Hagan, Arthur M.
Hansell, James M.
Haring, Louis H., Jr.
Herring, L. B.
Houston, Sam H., Jr.
Isenberger, N. P.
Jolley, Durward N.
Kelsey, Lewis O.
Leonard, Clarence Z.
Lock, John Henry
Maley, W. A.
Meyers, P. A.
Miller, Carroll C.
Neer, Carl J.
Nelson, Raymond T.
Newell, Donald F.
Owens, Frith C.
Parrish, Gaston H.
Poole, John C.
Pressler, Edward D.
Price, W. Armstrong
Ries, Minette
Schafer, Sidney
Seevers, Harris N
Stein, Ira H.
Storm, Lynn W.
Taegel, Edwin A
Teagle, John
Tucker, Reagan
Voigt, Harold E.
Williams, Carroll L.
Wood, Owen Bishop
DALLAS
Albritton, Claude C., Jr.
Allen, E. G.
Aronson, Sam M.
Bartell, Laurence D.
Beers, Roland F.
Benke, Roy
Bostick, J. Wallace
Brooks, Olin D.
Burress, Walter M.
Byrd, David Harold
Carpenter, Charles B.
Carter, Devere V.
Cesinger, E. F.
Chaddick, W. M., Jr.
Clark, John W.
Clawson, William W.
Collingwood, D. M.
Cortes, Henry C.
Cox, W. Philip
Crawford, David J.
DeGolyer, E.
Deputy, P. R.
Doering, John
Dunlap, Robert C.
Ekholm, V. E.
Fisher, Barney
Forsyth, Roderick J.
Fosdick, Arthur R.
Frost, Jack
Garrett, Melvin M.
Germany, E. B.
Gray, Alfred
Green, Cecil H.
Guthrie, Robert K.
Hager, Dilworth S.
Hammill, Chester A.
Heath, Francis E.
Hill, Harry B.
Hill, Robert T.
Hopkins, Edwin B.
Joekel, Fred E.
Karcher, John C.
Kelsey, Martin C.
Kendrick, Frank E.
Keppler, Leo G.
Knox, T. K.
Lahee, Frederic H.
Lewis, James A.
Love, Perry R.
Luman, Edmondson D.
MacNaughton, Lewis W.
Mayfield, Gid C.
McCutchan, Roscoe C.
McDermott, Eugene
McFarland, Paul W.
McFarland, R. S.
McGhee, George C.
Menefee, James C.
Meredith, Carlton
Meyer, Willis G.
Monsour, Emil
Morgan, Henry J., Jr.
Nash, Paul E.
O'Brien, Jerome J.
Oldham, Albert E.
Pittman, C. V. A.
Pollard, Jack C.
Ralston, Wallace
Rettger, R. E.
Rider, Charles R.
Robinson, Heath M.
Russ, Leon F.
Sale, Clarence M.
Schwarz, Melbert E.
Sclater, Kenneth C.
Shuler, Ellis W.
Simkins, J. J.
Smith, Lee C.
Stehr, Raymond A.
Stephenson, C. D.
Teichman, Joseph B.
Thomas, James W.
Thompson, Sheridan A.
Vanderpool, Harold C.
Walton, O. E.
Warren, John Edwin
Waters, James A.
Wender, W. G.
White, Rex H.
Wilson, Malcolm E.
Wrather, W. E.
DENISON—Foley, Edward J.
EAGLE—Moir, John
EAGLE PASS—Rank, R. A.
EASTLAND
Harden, Lynn L.
Perkins, Joseph M.
Russell, P. G.
Steel, Robert J.
EDINBURG
Curry, Robert Bruce
North, Lloyd
FORT STOCKTON
Samuell, John Howard
FORT WORTH—Abbott, John L.
Ackers, A. L.
Adkisson, Albert
Allen, Alton C.
Applin, Paul L.
Aurin, Fritz L.
Bass, Perry R.
Bennett, Ethel Evans
Benton, L. B.
Berger, Walter R.
Bradfield, Herbert H.
Bradish, Ford
Brown, J. Earle
Carpenter, Margaret C.
Casteel, S. H.
Christie, Robert S.
Christner, D. D.
Clark, G. C.
Clark, H. Smith
Conger, Lauren Tenney
Cordry, C. D.
Cummins, R. H.
Dean, D. P.
Dean, P. C.
Donoghue, David
Fash, Ralph H.
Freedman, L. H.
Fuqua, H. B.
Goodrich, Robert D.
Hilseweck, William J.
Hudson, William A.
Hyde, Clarence E.
Imbt, Robert F.
Johnston, Lois L.
Kennedy, J. B.
Liddle, Ralph A.
Lovejoy, J. B.
Markley, Joseph H.
Marshall, F. E.
Maverick, Phillip
McCaskey, Morgan E.
McClure, Harold Y.
Mills, Lloyd C.
Nicol, David
Nolte, William J.
Phipps, J. B.
Pilcher, Ben L.
Poulsen, Frank E.
Powell, Ralph S.
Prettyman, T. M.
Reeves, Frank W.
Renaud, Charles L.
Reynolds, Roy A.

Romine, Thomas B.
Scott, Gayle
Seaman, L. O.
Shay, D. C.
Smith, Ralph E.
Snebold, William F.
Thomas, Norman L.
Thompson, B. E.
Thompson, R. R.
Upson, M. E.
Vanderpool, Eugene W.
Wilson, John H.
Winton, Will M.
Yager, Charles E.
Yockstick, Fred F.
GAINESVILLE
Hunzicker, Vernon J.
GRAHAM—Becker, Raymond C.
GROESBECK—Whitcomb, Bruce
HOUSTON—Adams, Frank C.
Adkins, W. S.
Adler, Joseph L.
Albertson, Maurice M.
Allen, Stanley R.
Allison, A. P.
Anderson, John G.
Andrau, E. W. K.
Andrews, W. W.
Angle, W. M.
Archie, Gustave E.
Augenthaler, Robert L.
Back, Denys H.
Bader, G. E.
Bailey, Thomas L.
Baker, William A., Jr.
Baldwin, E. B.
Barragy, Edward J.
Barrow, Leonidas T.
Barton, Donald C.
Bauernschmidt, A. J.
Beckelhymer, Roy L.
Bell, Douglas E.
Bell, Olin G.
Belt, Ben C.
Best, J. Boyd
Bevier, George M.
Black, Jo Pat
Blackburn, Willis C.
Blanchard, W. Grant
Blau, Ludwig W.
Bolinger, John W.
Boone, Dan E.
Booth, Robert T.
Born, Howard R.
Bowles, R. C.
Bowling, Leslie
Bowman, Wayne F.
Boyles, James M.
Brace, Orval L.
Brauenstein, Jules
Brehm, Ralph C.
Briard, Vernon E.
Briggs, Robert C.
Broussard, David F.
Broussard, Lloyd J.
Brucks, E. W.
Brundall, Laurence
Bruyere, Alan
Buchanan, George S.
Buck, E. O.
Bunsen, A. W.
Burchfiel, Hugh L.
Burke, James D.
Burkhead, W. Z.
Butcher, S. D.
Byers, J. W.
Calohan, William F.
Campbell, F. F.
Carey, Hillard W.
Carlton, Dave P.
Carr, George W.
Cartwright, Lon D.
Casey, S. Russell
Cashin, D'Arcy M.
Cate, G. Odwin
Chambers, Jack
Childerhose, Allen J.
Christie, Laurence G.
Church, Charles R., Jr.
Claiborne, Ray E.
Clark, George H.
Clark, Robert P.
Clark, William A.
Clifford, O. C., Jr.
Cogen, William M.
Colle, Jack Overton
Collett, J. Daviss, Jr.
Collins, C. Philip
Conrad, Charles S.
Constant, Warren L.
Copeland, Robert R.
Crandall, Kenneth H.
Crowell, John H.
Crump, John Gillman H.
Cruse, John S., Jr.
Culbertson, J. Archer
Davis, Donald M.
Davis, Flavy Eugene
Davis, Morgan J.
Decker, LaVerne
Deming, J. H.
Deussen, Alexander
Dissinger, Earl
Dorr, James B.
Earl, Eugene L.
Eby, J. Brian
Edgerton, Charles E.
Edson, Dwight J.
Ellis, Albert D., Jr.
Ellisor, Alva C.
Evans, Frank G.
Fahle, Paul B.
Ferguson, Hershal C.
Ferguson, Kenneth H.
Ferrando, A.
Flowers, Jack
Fly, Paul J.
Fohs, F. Julius
Franklin, Louis
Fritts, Harold M.
Funkhouser, E. M.
Galbraith, T. J.
Garrett, J. B.
Garrett, L. P.
Goerner, Fred S.
Golden, John M.
Goldston, Walter L., Jr.
Goldstone, Frank
Goodrich, Paul K.
Goodrich, Raymond H.
Gordon, Dugald
Gorman, William A.
Gravell, Donald W.
Gray, Shapleigh G.
Griffin, Irving M.
Grimes, Russell W.
Guseman, L. F.
Guyod, Hubert
Hagen, Cecil Vernon
Hager, Lee
Halbouty, M. T.
Halsted, Morris E.
Hamm, W. Dow
Hamman, John, Jr.
Hancock, William T., Jr.
Hanna, Marcus A.
Hansard, Charles O., Jr.
Hardison, Harvey
Harkins, T. I.
Hartley, Burton
Harvey, Castle J. C.
Hasselmann, Karl F.
Hedley, J. David
Herold, C. Lathrop
Heroy, William B.
Higgs, Morton T.
Hinson, Hillord
Hoard, J. O.
Holland, Richard M., Jr.
Hoover, J. W.
Hornberger, Joseph, Jr.
Horner, William L.
Horton, Harold M.
Housh, C. N.
Hubbard, William E.
Hunter, Paul B.
Hutchinson, Frederick M.
Igau, Hubert C.
Israelsky, Merle C.
Ivy, John Smith
Jay, Stanley E.
Jenny, W. P.
Johnson, Samuel C.
Johnston, Harry W.
Jones, Robert L.
Jones, Wayne V.
Judson, Sidney A.
Kemp, H. S.
Kerlin, M. L., Jr.
Kilian, Harry
Kisling, James W., Jr.
Konkel, Philip M.
Kornfeld, M. M.
Ladner, A. L.
Lake, Charles L.
Lancaster, L. Kenneth
LaRue, James E.
LaRue, Wilton W.
Lasky, Bernard H.
Lay, Roy L.
Leavenworth, Paul B.
Leonardon, E. G.
Lieb, Victor E.
Lowman, Shepard W.
Lucky, M. C.
Lund, Gage V.
Lyons, Richard T.
Manes, O. B.
Marr, John D.
Marston, R. L.
Martyn, Phillip F.
Mason, Shirley L.
Mathes, Donald E.
Mayer, Edward A.
McCready, Harry J., Jr.
McDonnold, H. W.
McFerron, George I.
McGowan, F. H.
McGillan, Joseph M., Jr.
McReynolds, Gregg F.
Mebane, Robert Duff
Metcalf, Roy J.
Michaux, Frank W., Jr.
Miller, Arthur Barrett, Jr.
Miller, Forrest J.
Miller, John C.
Minton, W. B., Jr.
Minor, H. E.
Mitchell, George D.
Mitchell, Robert B.
Montgomery, James C.
Moore, William B.
Mornhinveg, A. R.
Morris, Louis H.
Morrison, T. E.
Morse, Roy R.
Mossman, R. W.
Mueller, Frederick W.
Murchison, Eugene A.
Myers, John C.
Nance, A. G.
Nance, J. B.
Neill, Wenzel B.
Niven, Robert N.
Noble, Homer A.
O'Bannon, P. H.
O'Donnell, Lawrence
Olcott, David Perry
Orynski, Leonard W.
Osterhoudt, Walter J.
Owen Kenneth Dale
Parker, W. G.

Patrick, Walden W.
Paxson, Roland B.
Payne, Willard M.
Peacock, Henry Bates
Porter, Phil
Reasoner, M. A.
Redfield, Robert C.
Reed, Edwin M.
Reese, Donald M.
Reiter, Wilhelm A.
Reynolds, F. F.
Richardson, Carl B.
Richardson, H. T.
Roberts, Louis C., Jr.
Robertson, Glenn D.
Rolshausen, F. W.
Roper, Frank C.
Rosaire, Carol G.
Rosaire, E. E.
Ross, E. McIver, Jr.
Runion, Felix A.
Russell, C. A.
Sample, Charles Hurst
Sanders, C. W., Jr.
Sappington, Chester
Sasse, Jerome B.
Saville, Wilson G.
Sawtelle, George
Say, Stanley R.
Scholl, Louis A., Jr.
Schumacher, J. P.
Schwennesen, Alvin T.
Scott, W. W.
Scruggs, M. Dale
Selig, A. L.
Seren, Gordon W.
Setzer, Francis Marion
Sherar, Edgar Smith
Sherar, Stuart
Smiser, Jerome S.
Smith, A. E.
Smith, Aylwin L.
Smith, Erwin W.
Smith, Fred E.
Smith, Fred Lewis
Smith, Gerald J.
Sorenson, I. L.
Spears, Walter H.
Speed, C. D., Jr.
Spooner, K. K.
Spoor, Harry C., Jr.
St. Germain, R. J.
Stamey, Roderick A.
Steig, Maynard H.
Steinberger, Clark R.
Stevens, George D.
Stewart, Charles A.
Stewart, Charles H.
Stiles, Elisabeth
Still, J. T.
Stuckey, Charles W., Jr.
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Sundt, O. F.
Sutton, Chase E.
Swigart, T. E.
Tash, George E.
Tatum, Emmett P.
Taylor, Josiah
Teas, L. P.
Teten, R. P.
Thomas, J. Elmer
Thompson, Evan G.
Thompson, John P.
Thompson, Wallace C.
Todd, John D.
Torrey, Paul D.
Troxell, John N.
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Uhrig, Leonard F.
Van Melle, F. A.
Vaudoit, Paul L.
Vesely, Leon R.
Vetter, John M.
Wall, Earle R.
Warner, Charles A.
Warren, Howard C.
Weatherston, Douglas
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Wheeler, James D.
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White, Gordon H.
White, Richard D.
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Poultney—Larrabee, David M.

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Blacksburg—Holden, Roy J.
Charlottesville
McGill, William M.

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Pullman—Culver, Harold E.
Glover, Sheldon L.
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Weaver, Charles E.

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Charleston
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Lafferty, Robert C., Jr.
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Mayfield, William W.
Tollefson, E. H.
Lewisburg
Argabrite, William Graeme
Morgantown
Galpin, Sidney L.
Heck, Edward T.
Hennen, Ray V.
Lucke, John B.
Price, Paul H.
Reger, David B.
Tucker, Rietz C.

WISCONSIN

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WYOMING

Casper—Barrett, Albert F.
Funk, Fred J.
Jones, Charles T.
Krampert, E. W.
Larsen, Raymond M.
Nelson, Walter S.
Seale, Robert I.
Stipp, Thomas F.
Laramie—Beckwith, R. H.
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Snively, H. Norman
Thomas, Horace D.
McFadden
McCanne, Rolland W.
Rock Springs
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Thermopolis
Schwabrow, John R.

OUTSIDE UNITED STATES

ARABIA

JUBAIL—Harriss, Trewhitt F

ARGENTINA

BUENOS AIRES—Feruglio, Egidio
Fossa-Mancini, Enrico
Leidhold, Clemens
Rozlosnik, Andres
Ruby, Glen M.
Severson, George A.
Sgrosso, Pascual
Shaw, Everett S.
Tarragona, Jose
SALTA—Fields, Harry B.
Harrington, George L.

AUSTRALIA

CANBERRA—Wade, Arthur
Woolnough, W. G.
CLOVELLY—Stanley, G. A. V
MELBOURNE
Milstein, M.
Rudd, Eric A.
PERTH—Moss, Frank A.
SYDNEY—Carey, S. Warren
Montgomery, John Norris
Raggatt, Harold G.

AUSTRIA

LEOBEN—Petrascheck, Wilhelm

BELGIUM

BRUSSELS—Hoffmann, Charles R.
Touwaide, M. E.

BURMA

RANGOON—Gevaerts, E. A. L.

CANADA

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Taylor, Vernon
CALGARY—Davies, Stanley J.
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Hunter, Harry M.
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Johnson, Russell V.
Link, Theodore A.
Sanderson, J. O. G.
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Ball, Max W.
TURNER VALLEY
Mackenzie, W. D. C.

BRITISH COLUMBIA

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ONTARIO

OTTAWA—Hume, George S.
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Wheeler, Orby Clinton

CENTRAL AMERICA

GUATEMALA
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Merritt, Roy W.
Tschopp, H. I.

COLOMBIA

BARRANCA-BERMEJA
Campbell, W. R.
Hughes, Richard V.
Sheldon, Robert A.
Waring, W. W.
BARRANQUILLA
Wood, George R.
BOGOTA—Alvarado, Benjamin
Breitenstein, Robert S.
Guerrero, Alberto Lobo-
Kirby, Louie C.
McArthur, Donald
Morgan, D. E.
Notestein, Frank B.
Trumpy, D.
Wheeler, Russell B.
CUCUTA—Bowler, James W.
Hubman, Carl W.
Lee, Herbert V.
Petta, Joseph B.
Saville, C. William
Wilson, Joe G.
EL CENTRO—Wofford, H. R.
HONDA—Aitken, W. Ernest
IBAGUE—Etherington, Thomas J.
Lamon, Robert Scott
Tabor, Lawrence

CYPRUS

NICOSIA
Browne, Richard Vernon

DENMARK

COPENHAGEN—Baird, Chester
Bryan, Carl L.

EAST INDIES

BORNEO

OOST—Schlaich, E. P.

JAVA

BATAVIA C.—Koch, Thomas W.
Nelson, Richard

NEW GUINEA

BABO—Ayers, Floyd M.
Baak, Jan A.
Cox, Harris
Frischknecht, Gustav
Maddox, Walter H.
MADANG—Ongley, Montague
WEWAK—Edwards, Allan K. M.

PAPUA

DARU—Barrow, Geoffrey
Chawner, William D.
PORT MORESBY
Gray, K. Washington
O'Driscoll, Eugene P.
Taverne, N. J. M.
Weisbord, Norman E.

SUMATRA

MEDAN—Bell, A. Lyndon
Dorn, Conrad L.
Fox, James P.
Hulsewe, Gerard Jan
Storm, Alfred E.
Van Beveren, O. F.
PALEMBANG
Bard, Richards J.
McCobb, Harry W.
Winkler, B. O.

ECUADOR

GUAYAQUIL—Berwick, James D.
QUITO—Oppenheim, Victor E.

EGYPT

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Fath, A. E.
Haight, Harold W.
Henry, Schuyler B.
Lytel, Harvey M.
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Rigg, Robert M.

ENGLAND

FOLKESTONE
Macfadyen, William A.
LONDON—Baker, Norval E.
Boots, Paul, H.
Flagler, C. W.
Greig, Douglas A.
Howard, Arthur Henry
Hunter, Campbell
Illing, Vincent C.
Jones, D. Glynn
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Lees, George M.
Lepper, G. W.
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HAMBURG
Behrmann, Rolf Bernhard
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Rose, Stanford L.

IRAQ

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Salas, G. P.
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Grogan, Samuel A.

MOROCCO

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PARKER D. TRASK (1939)	N. W. BASS (1941)	BEN H. PARKER (1941)
MAURICE M. ALBERTSON (1940)		WENDELL P. RAND (1941)

The purpose of the research committee is the advancement of research within the field of petroleum geology. If members working actively in research on particular problems care to register with the research committee, the committee will be glad to aid them in any way it can and put them in touch with other men who are, or have been, working on similar or allied problems and can perhaps effect some integration of the research work of the Association. If the younger, or older, members of the Association, who are doing or preparing research for publication, will come to any member of the committee, he will be very glad to offer whatever advice, counsel, or criticism he can in regard to the research, its prosecution, or its preparation for formal presentation. The committee would be glad to have members formulate and present to it suggestions in regard to research problems and programs.

SURVEY OF RESEARCH OPINION[1]

A. I. LEVORSEN[2]
Tulsa, Oklahoma

The research committee of the Association attempted a survey of the opinions of the membership of the Association as to the subjects for research which they believed to be the most valuable and useful to the field of petroleum geology. This survey was made by sending to each member and associate member the following post card and reply card.

Tulsa, Oklahoma,
December 10, 1938

TO: Members and Associates of the A.A.P.G.

As Chairman of the Research Committee of the Association, I desire to secure a cross section of your opinions as to the subjects for research which you believe to be the most valuable and useful to the field of petroleum geology and to you as a petroleum geologist. In other words, in using the attached reply card (or *preferably write a letter* giving a fuller expression of your ideas) think of answering the question of a research worker in geology who asks "What lines of research do you recommend as being most important to the further progress of petroleum geology?"

The subjects listed on the reply card are merely suggestions—you may not like them or you may have others which I hope you will add. This method of obtaining your ideas is not entirely satisfactory but I believe will give us something of value to work on and your cooperation will be greatly appreciated. The results of this survey will be published in the Bulletin.

Sincerely yours,
A. I. LEVORSEN

[1] Manuscript received, February 7, 1939.

[2] Chairman, research committee, 221 Woodward Boulevard.

(Reply Card)

TO: Research Committee of A.A.P.G.

Following is my opinion of those fields of geological research which I believe are of most importance to the progress of petroleum geology and the fields in which I would like to see research encouraged. They are numbered in the order of my preference.

Preference: Subject:

—— The origin of oil and gas.
—— The migration and accumulation of oil and gas.
—— Chemical and physical relations of oil, gas, and water.
—— Reservoir conditions, permeability, porosity, etc.
—— Sedimentation, environment of deposition, etc.
—— Structural relations in oil pools. —— Carbon ratio.
—— Stratigraphic relations in oil pools. —— Technique.
—— Geophysics. —— Oil field engineering. —— Paleontology.
—— ——————————————————————
—— ——————————————————————
—— ——————————————————————

(Signed)——————————————————————

—— Member —— Associate

More than 1,100 replies have been received and a statistical summary of these replies is shown in Table I.

TABLE I

Subjects for Research	Number of												
	1st Choices	*2nd Choices*	*3rd Choices*	*Total—First Three Choices*	*4th Choices*	*5th Choices*	*6th Choices*	*7th Choices*	*8th Choices*	*9th Choices*	*10th Choices*	*11th Choices*	*12th Choices*
Sedimentation, environment of deposition, etc.	245	176	178	599	101	63	37	24	17	17	4	4	4
Migration and accumulation of oil and gas	208	104	117	519	99	87	67	27	14	9	6	3	1
Reservoir conditions, permeability, porosity, etc.	187	166	164	519	124	96	55	35	19	4	4	2	—
Stratigraphic relations in oil fields	103	187	169	459	102	109	69	61	15	7	1	3	—
Structural relations in oil fields	111	158	128	397	122	84	89	37	14	6	4	5	—
Origin of oil and gas	162	75	48	285	55	61	58	42	39	29	22	21	22
Chemical and physical relations of oil, gas, and water	60	85	77	182	75	63	63	80	70	38	15	7	5
Geophysics	52	45	61	158	58	43	47	60	84	42	36	21	18
Oil-field engineering	15	23	29	67	36	29	40	33	48	69	46	42	31
Paleontology	11	13	32	56	29	24	22	33	47	61	75	38	42
Carbon ratio	1	3	9	13	10	13	7	21	24	28	67	68	115
Technique	4	3	5	12	7	16	8	15	33	50	66	112	46

Note: In tabulating those cards marked by "x" instead of by numerals, three "x's" were counted as three "2nd choices" while five "x's" were counted as a "3rd choice" for each of the marked subjects.

Many members added comments to the reply card. A selected group of these comments which it is believed are of general interest follows.

Nature and origin of oil producing materials—vegetable, animal or other.—F. M. Anderson, Berkeley, Calif.

Better geological interpretation of geophysical results is of most importance.—Chester F. Barnes, Big Spring, Tex.

Metamorphism (or alteration) of sediments from time of deposition to consolidation.—Eliot Blackwelder, Palo Alto, Calif.

Analysis and interpretation of cores on drilling wells, as well as studies of Schlumberger and other surveys to more accurately determine the possibilities of formations before casing is run and tests are made.—H. T. Brown, Oklahoma City, Okla.

Would like to see research encouraged on ultimate recoveries in sand and lime pools.—ROBERT BROWN, Shawnee, Okla.

Paleogeographic studies on source beds and reservoir beds.—FRED M. BULLARD, Austin, Tex.

Time of deformation as related to time of accumulation or migration.—KATHARINE CARMAN, Chicago, Ill.

Survey to determine recoverable reserves in pools, depleted by old flowing and pumping methods, through water flooding and gas re-cycling.—S. H. CASTEEL, Fort Worth, Tex.

Summaries of historical geology of various oil provinces.—RALPH S. COOLEY, Midland, Tex.

Origin of oil may only be inferred. The story of migration and accumulation has never been adequately told. We now have a mass of information on that which should be correlated and compiled.—ERIC K. CRAIG, Bakersfield, Calif.

The ecology of micro-organisms is essential for refined correlation—this field is relatively untouched.—RODMAN K. CROSS, Santa Maria, Calif.

Relation of recovery to spacing. Effect of repressuring on recovery.—WILLARD W. CUTLER, JR., Los Angeles, Calif.

The whole subject of structural geology has been neglected, especially east of the Mississippi River.—NATHAN C. DAVIES, Wellsville, N. Y.

Percent recovery of oil and dry gas from fields by normal methods by 10-20-40-acre spacing on oil and 40-80-160-acre spacing for dry gas. Also some data for oil by repressuring. There has been a lot of guess work on this but few facts.—KURT H. DE COUSSER, Lansing, Mich.

Study of wave (sound) velocities, physical properties and constants of various general and specific rocks and formations.—C. H. DRESBACH, Pittsburgh, Pa.

General Geology (The Foundation for Petroleum Geology). There is too much oil and not enough geology in the organization.—J. E. EATON, Los Angeles, Calif.

Why do some sands carry oil and others carry salt water within a short stratigraphic range in the same well? (Specific problem.)—JOHN L. FERGUSON, Tulsa, Okla.

Methods of determining degree of metamorphism other than carbon ratio in coal.—CHAS. R. FETTKE, Pittsburgh, Pa.

Drainage conditions in pools where acid is used.—WILLIAM R. GAHRING, Shawnee, Okla.

Chemical and physical changes from organic matter to hydrocarbons, and their causes.—J. J. GALLOWAY, Bloomington, Ind.

Reserves and values under curtailment. Differentiation between fresh water and tar zones in electric logs.—CHESTER M. GARDINER, Los Angeles, Calif.

How to increase further *ultimate recovery* from oil sands.—L. C. GLENN, Nashville, Tenn.

Time of accumulation into present reservoirs.—FRANK GOUIN, Duncan, Okla.

Reefs—particularly Paleozoic reefs. I do not find much in the literature.—FRED M. HAASE, Abilene, Tex.

Stratigraphic traps (structural or sedimentary) is a subject worthy of considerable research.—J. M. HAMILL, Los Angeles, Calif.

Would like to see some work on relation of oil-gas ratios to age of accumulation or formation of reservoir.—CASTLE J. C. HARVEY, Houston, Tex.

Present-day distribution of sediments in enclosed basins.—JOSEPH S. HOLLISTER, Santa Barbara, Calif.

Origin of dolomite—abrupt change from limestone to dolomite in some strata.—RAYMOND S. HUNT, Saginaw, Mich.

How to handle oil field brines so as to protect surface and ground water.—OGDEN S. JONES, Topeka, Kan.

Believe some further attempts should be made to learn more about the relationship between the origin of oil and sedimentation.—W. S. W. KEW, Los Angeles, Calif.

The possibility of the inorganic formation of oil (chemical generation).—MAX KRUEGER, Los Angeles, Calif.

Regional fault patterns in relationship to oil and gas fields.—ROBERT C. LAFFERTY, Charleston, W. Va.

The estimation of oil reserves.—BEN E. LINDSLY, Washington, D. C.

More detailed studies of structural and stratigrpahic relations between oil accumulations and possible source beds.—FREDERICK S. LOTT, Bartlesville, Okla.

Correlation (if any) between sedimentation on present and ancient shorelines.—JOHN B. LUCKE, Morgantown, W. Va.

Recovery in abandoned fields by mining methods. Repressuring in abandoned or depleted fields.—A. L. LUGN, Lincoln, Neb.

I feel that the study of dolomites, both secondary and primary, would be very beneficial.—JED B. MAEBIUS, Saginaw, Mich.

I would like to see some work done toward arriving at some workable set of formulas for use in determining reserves, with factors that can be determined by observing porosity, saturation, pressure and specific gravity.—ATLEE MANTHOS, San Antonio, Tex.

Relation of structural basins to accumulation of oil.—GID S. MAYFIELD, Dallas, Tex.

Further study of the nitrogen-reduction ratio.—F. H. MCGUIGAN, Owensboro, Ky.

Per cent recovery of oil and gas from sands in depleted fields.—H. J. MCLELLAN, Tyler, Tex.

Critical work on paleogeography in order to attack stratigraphic traps problem is especially important, I think.—R. C. MOORE, Lawrence, Kan.

Articles on something *besides forams* would be greatly appreciated.—DAVID NICOL, Fort Worth, Tex.

Petroleum economics—primarily the future supply and demand of natural petroleum.—GLEN S. NORVILLE, Oklahoma City, Okla.

Relationship of bottom hole pressure to production of oil.—JACOB L. PATTON, Geismer, La.

Studies on the geological history of oil pools.—R. D. REED, Los Angeles, Calif.

The influence of heat and pressure in generating oil and gas from organic sediments—by all odds most needed research.—JOHN L. RICH, Cincinnati, Ohio.

The rate of movement of water as compared with oil and gas in the same oil pool is also a highly important matter for additional research work.—P. A. ROBERTSON, Tyler, Tex.

Reefs as oil reservoirs.—J. J. RUSSELL, JR., Wichita Falls, Tex.

Lenticular deposition as trap for oil. Comparison of present and ancient types deposition.—I. R. SHELDON, San Antonio, Tex.

The inter-relations between stratigraphy, sedimentation and tectonic history.—R. E. SHERRILL, Pittsburgh, Pa.

I should like more articles on foreign oil fields.—EDWARD C. SIMPSON, Bakersfield, Calif.

Origin of "reefs" and their relation to structurally positive areas as influenced by the migration and accumulation of oil and gas.—EARL M. STILLEY, Wichita Falls, Tex.

Origin of the pressure in wells. A full study of the minor constituents in oil. In what way—if any—do they bear on the origin of oil and gas?—W. A. TARR, Columbia, Mo.

The origin of oil and gas is of least importance. All other subjects listed are equal in importance, I believe.—JOSIAH TAYLOR, Houston, Tex.

Elevation and configuration of "basement" surface. Structure and composition of rocks within basement complex (as discoverable by, or affecting, geophysical exploration methods).—W. T. THOM, JR., Princeton, N. J.

Remaining saturation and reserves in old pools. Study of recovery records in relation to well spacing and recovery methods and reservoir conditions and rate of recovery.—C. W. TOMLINSON, Ardmore, Okla.

Estimating reserves under present producing practices.—J. N. TROXELL, Houston, Tex.

Classification of oil-field basins. Physical, including optical properties, of oil as aid to classification, determination of origin of oil as an aid in exploration, along with allied geochemical studies.—L. G. WEEKS, New York.

Variations in the gravity of oil in same pool.—H. A. WHEELER, Saint Louis, Mo.

Relation of producing areas to source of sediments.—L. M. WILSHIRE, Tulsa, Okla.

Criteria for recognizing metamorphism in non-coal bearing sediments. A.A.P.G. should give $1,000.00 or more each year in aiding research projects.—W. B. WILSON, Tulsa, Okla.

In my area the conditions of sedimentation that are vital to oil hold the secret to the difference between a structurally high well that pays off and one that doesn't.—CHAS. F. WORD, Abilene, Tex.

Fakes of geophysical instruments—such as "doodle bugs." I find quite a number of operators using various instruments. My research shows the inventor has no knowledge of geology whatsoever.—FRED F. YOCKSTICK, Fort Worth, Tex.

In addition to the foregoing comments many members wrote letters giving a fuller expression of their ideas of research in the field of petroleum geology. They reflect a wide range of interest on the subject of research. Following are excerpts from these letters which are of general interest.

Future progress in petroleum geology depends very much upon a "meeting of minds" of physicists, chemists and geologists. The relations of the reservoir fluids is a problem in physics and chemistry, as well as in geology. As regards the chemical nature of crude petroleums we are still very much in the dark and present and future studies such as those now in progress as the Bureau of Standards, will doubtless be fruitful.—A. H. BELL, Geologist and head, Oil and Gas Division, State Geological Survey Division, Urbana, Ill.

The first subjects which occurred to me are ones which are now confronting me in Michigan.

In Michigan it appears as though much research should be done in connection with:

1. Determining why and the conditions governing the secondary dolomitization of the Dundee limestone and Monroe limestone. Porosity will be highly developed by such dolomitization accounting for accumulation of oil in paying quantities, while tests adjoining or closeby will find the Dundee in an unaltered state with a much lesser degree of porosity and in some instances void of accumulation of oil or gas. Two wells of the same structural position may be examples of both these conditions. The dolomitization does not appear to be entirely governed by structural conditions.

2. A research study into the tectonics of the structural folding in Michigan would be of interest. It appears to the writer there is a more or less definite pattern followed by the folds in this state, resulting in a rather complex series of *en échelon* folds. A study of cross folding would be of much value.—PAUL M. BUTTERMORE, Chartiers Oil Co., Pittsburgh, Pa.

I would like to suggest a topic which I feel deserves more attention from us. It is: "Utilization of gas." I refer to the fuller utilization of the reservoir energy and the fuel value of gas which is now being produced in conjunction with crude oil.

My viewpoint in the matter is perhaps more that of an economist than of a geologist or geophysicist, but I feel very keenly that full advantage is not being taken of a great natural resource which has been found largely as a result of geological effort. There are some outstanding examples of utilization of gas such as the Humble development at Sugarland and re-cycling plants are being installed in several fields at the present time, still the utilization of gas to the fullest extent is the exception rather than the rule in the Mid-Continent oil fields.

For a constructive program to encourage utilization of gas energy to a greater extent, I would suggest that the first step is an educational one to develop a consciousness of the problem and present ways and means of tackling it. This perhaps is not the chief function of the research committee, but research is wasted unless the results of it become known and applied, so one of your functions is directly related to this step of the problem. Certainly the correlation and publication of developments by individuals and companies as private business is one of the functions of the committee.

The undertaking of new lines of research would be the second step I would suggest. It seems to me that the problem is intimately related to at least two of the fields of research mentioned on the enclosed card, namely, reservoir conditions, and oil-field engineering. Reservoir conditions determine how much gas energy is available and how it may be used. Oil-field engineering covers the practices which determine whether or not the gas energy is used to fullest advantage.

From a very cursory study of the problem it is my opinion that much is not being done that could be done because of the diversity of ownership in the oil fields. Here again we have the broad problem of civilization; the organization of selfish individuals into a cooperative effort that will make the best possible use of man's technical progress. I submit that the utilization of gas offers our association an immediate and practical field in which to make an advance in the broader problem facing all of us.—F. F. CAMPBELL, Amerada Petroleum Corp., Tulsa, Okla.

There is a considerable amount of research and what is called research in the subject of petroleum by a number of organizations. Aside from the work carried on by Federal and State bureaus, there is a research committee in the American Petroleum Institute which has a very decent budget on which to operate and a production division of the American Institute of Mining Engineers to which scientific papers are contributed by individuals and companies. Aside from these, of course, are the research departments of the companies which from time to time make contributions to the general fund of knowledge when such information can be released. This latter source of information can, in general, be disregarded as it is too uncertain. As to the others, however, it is probably too much to hope that complete coördination can ever be obtained. Without coördination, however, we suffer from lack of interchange of ideas among the various research groups, waste resulting from the duplication of facilities and waste from the duplication of effort. Just who should take the lead in attempting to coördinate this work, it is difficult to say, but it would be very valuable to the petroleum geologists and to the Industry if this could be done. In the absence of it, it is my feeling that the American Association of Petroleum Geologists should confine itself within the limits of a strict definition of petroleum geology which would result in its research efforts being confined to such subjects as the genesis of petroleum and the structural stratigraphic relations in oil fields, leaving such subjects as the study of recovery methods, etc., to the engineering societies and bureaus. Even if this be done, there remains the need for coödination of this work which the similar work being done by the Geological Survey and the American Petroleum Institute and possibly your program could include a review of all these activities with recommendations for coördination. W. B. Case, New York City.

In connection with your inquiry as to subjects for research in petroleum geology, I suggest that some investigation be made regarding non-productive structures. It is only natural that we have much more information about productive structures, but the record of unsuccessful tests emphasizes the importance of knowing why certain structures do not yield oil or gas. By having a compilation of data on this subject we might all be forewarned of conditions to look for in certain areas. The files of the Geological Departments of the major companies have many examples of unsuccessful tests. These could be contributed, anonymously if desired, showing only the general location and the reasons why production was not secured. It might be attributable to miscorrelation of outcrops, lack of reservoir, inadequate closure, age of fold, shifting of the structure with depth, or lack of folding in the deeper formations, etc. Any of these facts might be useful to a geologist interested in the related area. I believe this subject is worthy of attention due to the lack of published data now available.—Homer H. Charles, Phillips Petroleum Co., Bartlesville, Okla.

I should like to suggest the importance of study on the reservoir conditions, permeability, and porosity of oil and gas formations in producing fields, for the following reasons.

1. A thorough knowledge of the reservoir conditions would promote a better spacing program and the adoption of more uniform production methods and result in the saving of reservoir energy. An early study of the producing formations in a new pool to determine the character, thickness and saturation, the gas-bearing section, the oil and water levels, if they are determinable, would enable the operators to select the size, type, and kind of casing adaptable, and where and how to set it on the various pay zones.

2. An analysis of the oil and gas levels would permit the dissemination of general information through the various regulatory commissions now existing in nearly all states for the common good of all, and aid in the issuing of regulations to conserve and protect the deposits.

3. A study of reservoir conditions by the geologist would be of great value to the petroleum engineer or production manager. It shoud stimulate the perfection of better devices and methods of producing oil and gas economically and conservatively.

The greatest strides have been made in the perfection of drilling equipment and methods of boring wells to great depths in a remarkably short time. If a study of the natural conditions in pay horizons can open the way for a similar improvement in producing and conserving oil and gas, it will certainly be a highly practical help.

Five years' experience in drilling and operating in the Oklahoma City district has taught me that operators know too little about the pay horizons, even in sands more or

less uniform in nature. We have found that the "Wilcox" sand, having a maximum thickness of some 200 feet at Oklahoma City, has lean sections and rich sections existing within the sand body. These so-called pay streaks were gradually determined and by the time the operators really knew something about the sands' qualities, unavoidable mistakes in many cases were beyond remedy.—ALBERT S. CLINKSCALES, Oklahoma City, Okla.

In response to a recent request for suggestions on research subjects, I would like to call your attention to problems that have arisen in the practical applications of electrical logging.

In South Texas, problems of interpretation arise due to the following.

1. Character of rotary mud which includes the effect of different added chemicals and its salinity.

2. The effects of shale constituents in a sand which differs with the character of the shale itself.

3. The effect of bentonitic shale.

4. The possibility of different electrical effects due to different heavy mineral constituents in sand.

5. The effect of mud invasion which, of course, differs with the character of the mud.

6. The effect of calcareous and siliceous impurities in sand.

7. The effect of lignites which do not seem to have the same electrical properties in the different geological ages.

8. The whole field of electrical properties of limes.

The foregoing problems have been met to some extent by private research on the part of Schlumberger Corporation and by trial and error methods in the field by operators. However, there has been no systematic research that has yielded a comprehensive report to the petroleum geologists.

In our own experience, we have had physical analyses of a few cores made in order to evaluate Schlumberger results. However, the work has been haphazard. It occurred to us that if a study were made of the relationship between electrical properties and physical properties in specific formations, the results might be of considerable value to the petroleum geologist.

One difficulty with previous experimentation by companies doing electrical logging is that it has been done on formations foreign to our area. It is quite possible that a research program could be worked out jointly between companies doing electrical logging and the Association.—WM. H. CURRY, Wellington Oil Co. of Delaware, San Antonio, Tex.

I should like to suggest that in addition to the topics listed, some thought be given to "Structural Trends and Structural Patterns." It seems to me that most of us have pre-conceived ideas of trends which may or may not be entirely correct. This topic should also include the reasons why structures have certain relationships with reference to others. In brief, it seems possible and probable to me that structures could be located almost mathematically, if we could work out the physics and mathematics involved.

Another field of investigation which I think is of great importance in petroleum work is the "Investigation of Recent Microfaunas in Seas and Oceans" with the view of determining the ecologic conditions under which certain organisms lived. This would be of the greatest help in interpreting facies changes and in making correlations.—ROBERT H. CUYLER, University of Texas, Department of Geology, Austin, Tex.

1. Estimates of Petroleum reserves,—that is, oil in the ground.

This is the foundation upon which are based all buying and selling of producing properties and expensive non-producing leases; it is the line of investigation which most quickly commands the absorbed attention of those who are sponsoring exploration work; and the results of reserve studies are in a language all seem to understand. Every one wants to know, "how much oil have we got," or "how much oil will we get if we purchase this property," or "how much oil have we discovered this year."

It seems to me that a uniform, accurate-as-possible, *generally used* method of estimating the amounts of oil in the ground,—a method officially approved by the country's leading petroleum geologists and so obviously sound that the *reputable* geologists and

engineers of both buyer and seller could not consider using any other formula,—is a most urgent need at the present time. In conducting research in this field, I think past estimates should be examined for (1) the factors such as porosity, saturation, water level, *etc.*, which were used to arrive at the per-acre figures, (2) how the estimates turned out, and (3) why they were wrong.

2. Overlaps.

Probably as much oil is still to be discovered in overlaps as has already been recovered from folds and faults. Research in this field should first be directed to pointing out clearly what sedimentary and structural factors are responsible for overlaps. If possible this should be made so clear and so simple that petroleum geologists will acquire the same instinctive urge to be on the look-out for overlaps as they now are for folds and faults.

3. Improvement in geophsical technique for locating overlaps, regionally and also locally, as around salt domes.

4. Origin of oil and gas, with particular reference to specific criteria for recognizing, before drilling, that a rock section *can* be petroliferous.

The advancement of the science of geology, and the study of neglected fields of earth history are subjects which many geological societies are sponsoring, and it goes without saying that this is most desirable. But the solving of specific problems which day by day confront those who work with rocks in an effort to provide civilization with an adequate supply of petroleum seems to me to be peculiarly the specialized province of such research as is conducted by groups or associations of petroleum geologists.—GEO. E. DORSEY, Baltimore, Md.

I would like to make the following suggestion:

Study and tabulate every scrap of information available on the structural and stratigraphic relationships of every oil field in the world on which information can be obtained. Some common denominator of accumulation should come to light. Headings for the tabulation could include a break-down on different types of structural traps, age or ages of folding, type and age of reservoir rock. Other items would suggest themselves.

The study might be carried further by including data on the chemistry of the oil and perhaps of associated brines.

My idea would be for an inductive approach to the problem of accumulation, rather than the present deductive one.—ROBERT H. DOTT, State of Oklahoma Geological Survey, Norman, Okla.

Suggested problems for research work specifically for the San Joaquin Valley, California, are the following.

1. Time at which deformation occurred as suggested by unconformities and tilted strand lines.

2. Stress-strain relationship to folds and faults. This might require the application of the principles of the strain ellipsoid to folds and faults.

3. Competent and incompetent folding in the strong folds with emphasis on what happens to the folds at depth; and suggestions as to what may be expected at depths greater than have as yet been penetrated.

4. Areal extent of the various sand bodies; source areas of the sediments.

5. Seismograph: an analysis of the variation of the velocity curve in different parts of the Valley, with the thought in mind that possibly the type of sediment which underlies the location may have a strong influence in altering the velocity curve.—E. C. EDWARDS, General Petroleum Corp. of California, Los Angeles, Calif.

My personal opinion regarding the fields of geological research in furthering the progress of petroleum geology is that all of these fields are extremely important in the Tri-State area of Illinois, Indiana, and Kentucky. Working in this area, I am naturally interested in the problems encountered here rather than in those of the southwest and of California. Reservoir conditions, *etc.*, and sedimentation, *etc.*, are probably the most important factors in the study of the "McClosky sand" which so far is proving to be the major problem of the area. The application of micro-paleontology to the correlation of the Ste. Genevieve formation would undoubtedly lead to a better understanding of the stratigraphic relations in the pools. The success of geophysics in this region could undoubtedly be improved by research, particularly in the case of the gravity meter in

the interpretation of gravity features in terms of structural features.—STANLEY G. ELDER.

It appears to me that the most important problem is the one most difficult to attack; namely, the origin of oil and gas. While we can do considerable good working on some of the others without knowing the origin, it seems to me that we can get nowhere with migration until we know whether the origin is local or widespread or both. Accumulation is tied in rather closely with structure and stratigraphy and I think that we have made considerable progress with this line of investigation. Possibly structure, stratigraphy and accumulation could afford to rest awhile and wait for origin to catch up.

In my opinion, oilfield engineering and geophysics might well be left to other organizations which specialize in those subjects, except in the case of such problems which overlap the various branches of science.

It would be my suggestion to search out such men as have started research because of their own interest in particular problems and to give encouragement and aid to them. I doubt that much good comes from trying to drum up interest in research, and doubt particularly that much comes from men who want mainly the publicity which may come from it.—L. L. FOLEY, Petroleum engineer and geologist, Tulsa, Okla.

In California at the present, the interest in reservoir conditions in oil pools is much more important than any other line of research. Even though some of the other subjects you mentioned on your card deserve a great deal of attention, I think that a symposium on permeability and porosity and other problems relating to reservoir conditions would enable some of the west coast boys to catch up with you mid-continent experts. Some minor problems come up occasionally in this state that might be of interest elsewhwere. As you probably know, the fractured shale production in the Santa Maria field is a very worthwhile problem that deserves a great deal of attention from geologists who have worked with the Schlumberger outfit in that area. What they develop there may be of some value in other parts of California and even in other states.—E. W. GALLIHER, Barnsdall Oil Co., Los Angeles, Calif.

There is an additional subject which might be titled "Relation of Porosity and Saturation to Recovery Records," which I believe is a field of some directly usable information. Procedure that we have attempted is to examine samples, estimate porosity and saturation and percent of recovery to arrive at a quantitative figure for yield in barrels per acre. This information has been co-ordinated with actual performances on wells in which the samples were examined. Using this combination of information we have attempted to arrive at accurate figures for yield in barrels per acre foot of pay. This subject could be elaborated upon to include relationship of well spacing to yield per acre and the subject would have greater importance to the economics of developing an oil field and would thus be of primary importance to the industry.

If a geologist could be informed as to reservoir conditions, sedimentation, and stratigraphic relations, he would unquestionably be of greater service to the oil business, and it is my opinion that research on these three subjects should be encouraged.—RICHARD E. GILE, Midland, Tex.

The increasing occurrence of single phase fields is introducing many new problems which are yet unanswered by the gas engineer and geologist. The problems for research which this development introduces occur within and overlap the first seven problems designated on your card. To those of you outside of the South Texas district, this may not appear to be a major problem but it is not going to be many years until the products from the pressure maintenance plants in these fields are going to have an important position in the national production column. The products of these plants will ultimately displace a sizable amount of crude oil demand.—WESLEY G. GISH, Transwestern Oil Co., San Antonio, Tex.

A fundamental subject for research work has been generally neglected. I refer to the History of Petroleum, with its evolution and relationship to civilization. Every day it is seen that the oil industry, of which the petroleum geologist is a basic part, is becoming more and more interested in its own history. A real unbiased history of the industry affords a most comprehensive and fundamentally important research problem.—H. B. GOODRICH, Tulsa, Okla.

The lines of research which I would recommend as being most important to the further progress of petroleum geology are as follows.

1. Sedimentation, environment of deposition, with special emphasis on the accumulation of chemically precipitated and bio-chemically deposited sediments with special attention to the probable effects of mass-solubilities, temperatures, *etc.*, on the types of sediments which would result from different sets of conditions.

I place this subject first because in conversations with geologists generally, and especially those in commercial work and even more especially, those engaged in subsurface work, it has seemed to me that the chief aim of most workers is to make formational subdivisions, and that those who think at all about the conditions under which the rocks they are observing were deposited, are hampered in their thinking by loose habits of thought and careless choice of words, and a general lack of knowledge concerning the conditions of temperature, depth of water, strength of current, degree of salinity, and presence or absence of varying quantities of chemical elements and compounds which would be necessary for the deposition of different types of sediment.

I have keenly felt my own lack of adequate knowledge of these things, especially when trying to develop some notion of the conditions which must have attended the development of the present rocks in the limestone-dolomite-anhydrite sections in some of our sedimentary basins. The proper study of this matter would require the combined efforts of a well trained geologist, mineralogist, chemist and paleontologist and hence is somewhat beyond the scope of most active members of the A.A.P.G. Yet the considerations involved are of primary importance in the search for and development of oil fields in the calcareous and evaporite sections and so pursuance of this subject seems to be essentially a research problem.

2. Stratigraphic relations in oil pools.—While a great deal of good work has been done on this subject in recent years, even a casual perusal of the literature will turn up many conflicts, both of things stated as fact and as opinion, and most of these conflicts seem to arise at least partially, from the limited field of observation of any one reporter. An impartial research worker might be able to go a long way toward reconciling conflicting opinions and in so doing, would probably turn up a considerable number of important facts and relations which had been previously overlooked.

3. Chemical and physical relations of oil, gas, and water.—The importance of the chemical and physical relationships of oil, gas and water which occur in association in and near commercial pools seems to require no explanation or elaboration. There are, however, angles to this subject which are all too often taken for granted by geologists without being entirely explained or understood. Outstanding among these is the phenomenon of an oil or gas body under pressure of somewhat the same order of magnitude as the apparent local hydrostatic head but which does not appear to be under a water drive. I would like to know what are the physical and chemical relations surrounding such an oil body and especially when it occurs in a series of sands which are elsewhere capable of yielding water. What are the conditions which lock up such an oil body? Are the pores in the surrounding rocks filled by cementation and if so, when and under what conditions did such cementation take place?—B. F. HAKE, Gulf Refining Co., Indianapolis, Ind.

In my opinion the most important subject is origin or origins of oil and gas (or oils and gases). The great difficulty in this research is the direct approach. It seems to me there are a number of intermediate geological problems which must be solved before we can comprehend or define the ultimate problem of origins. This is, oil and gas encountered in the fields must be specifically explained in terms of migration, accumulation or occurrence *in situ*. Migration in pools is too well established to dismiss the subject of migration more distant than five or ten miles. Logically the origin of the oil would be solved after more is known as to the original environment.

While finding oil is a function of exploration, circumstances are more and more demanding the geologist realize the implications of economic conditions as brought about by proration, deeper drilling, *etc.* This subject of economics is surely the basis of all engineering and applied geology and the reason of their existence in the oil industry. However, economic views vary according to the individual, and in my opinion it is essential that the geologist more fully realize a responsibility to develop a sound, conservative viewpoint which will be reflected through his advice and recommendations. Therefore those better fitted to do research in economics from a geological viewpoint should be encouraged to publish worthwhile findings.—T. C. HIESTAND, Indian Territory Illuminating Oil Co., Bartlesville, Okla.

As one of the younger associates of the Association I should like to elucidate one of my views on the questionnaire your committee recently submitted.

My first choice is technique—as applied to professional ability in the larger sense. By larger sense, I mean the geologist's obligation to his profession and its standards of excellence.

Let me assure you that I realize that acquisition of technique is proportional to the effort and diligence of the individual and the ability of those with whom he works.

I feel that the Association could best assist its younger generation by having some of the more able members publish systematic analyses of probable future trends in the application of geological knowledge to the petroleum industry. I have in mind papers similar to the address of the president at the New Orleans meeting.—WILLIAM J. HILEWECK, Gulf Oil Corp., Fort Worth, Tex.

My suggestion of technique for rapid heavy mineral separation is made with the thought that the research committee might sponsor the publication of various types of technique which have already been developed but are not readily available to a large number of members who might be interested. I have not checked the suggestion of stratigraphic relations in oil pools in spite of the fact that it is one which California workers consider to be extremely important. My reason is that I believe oil companies consider this problem one of too direct and immediate economic importance either to discuss freely or to permit interpretation by someone outside their own organization.

Before any problem is accepted by the research committee, we should have a clean-cut statement of the probable value of results to be expected.—HAROLD W. HOOTS, Richfield Oil Corp., Los Angeles, Calif.

The principal idea which I am suggesting was born and has been nourished during my brief experience in running well samples and making lithologic determinations with the aid of the microscope. I sincerely believe that the increasing importance of the sample log and its associated microscopic work justifies considerable coöperative effort in increasing the contributions which this phase of petroleum geology can make to the whole science.

The suggestion I wish to advocate as a subject for investigation concerns the standardization of terminologies employed by microscopists in describing well samples. This standardization I believe should effect such characteristics as grain sizes, textures, colors, shapes, and similar data describing the microscopic appearance of a lithologic unit.

I can conceive that it would be quite possible that a complete collection of "type specimen" slides illustrative of these terms could be assembled by the large group of us who are engaged in sample examination. For examples, the "holotype" of well rounded, frosted sand grains would be a slide of "Wilcox" or St. Peter sand grains. The type slide of "oolitic porus limestone" could be a fragment of the McClosky oölite from the Illinois basin. The shales of the lower Chester, particularly the Paint Creek, could be used as illustrations of "red and green variegated shales." A series of such slides could be collected and placed on file in the offices of the Association, and would be at the disposal of geologists everywhere in the Mid-Continent region. Then, a mimeographed bulletin describing and listing these terms, together with the slide number, geologic horizon, well name and location, would be distributed to petroleum geologists interested in this phase of work. A type description from the bulletin could read as follows.

Oölitic Porous Limestone—McClosky Sand
Phillips Perryman No. 1, NW., SW., Sec. 1, T. 8 N., R. 1 E.
Fayette County, Ill. 1710–1715
A.A.P.G. No. 426 Contributed by: Daniel J. Jones

The nucleus of such a collection is being formed here in the geologic laboratory of our company at the present time.

In conjunction with this, type specimens of cores from important "pay horizons" could be collected and similarly placed at the disposal of the profession.—DANIEL J. JONES, Phillips Petroleum Co., Bartlesville, Okla.

It is my belief that one of the most important things about research work is to try and impress upon geologists to do "independent thinking." That is, not try to follow in a general line of thinking or investigation just because others are doing so. But let one's mind travel freely and independently.

Another important thing I believe, is to urge geologists to come forth with their ideas and information no matter how out of the ordinary they may seem. For some of these ideas or information may be on the right track.—KENT K. KIMBALL, Consulting geologist and petroleum engineer, Tulsa, Okla.

In reply to your card of inquiry regarding subjects of most use in the field of research, I have inserted the subject of Appraisal as I believe research and review of this subject would be of great practical assistance, and of increasing importance to the industry.—C. R. MCKNIGHT, Arkansas Fuel Oil Co., Shreveport, La.

In my eyes the most promising line is the study of source beds, both at the surface and from cores. Methods of testing for carbonaceous, bituminous and petroliferous fractions *in the field* should be sought after; the limitations of dry distillation studied; the factor of climate in leaching values at the surface, and the depth to which this factor is significant seem important.

The same ends could be achieved by work on the environment of source bed deposition, but practically this is not so useful a means.

Paleontology could be made a much more useful tool by the drawing of broad-minded generalizations as to the distinctions and similarities of guide-fossils (megascopic, of course) and the publication of these in non-biologic language. This is not exactly research; it means weeding out the meaningless and statement of the fossil succession in terms understandable by men whose main energies are not directed to paleontology.

In the states the regional picture has been very well developed, especially by such men as Reed. But tectonics in other parts of the globe must fall back far, even to Suess. The records of sedimentation and diastrophism for many areas might be gathered and presented merely as documentation. In time sufficient might accumulate to permit the drawing of valid and valuable conclusions.—JOHN F. MASON, Socony-Vacuum Oil Co., Katib el Habashi, Sinai.

Many of the problems confronting the petroleum geologist in California are directly related to sedimentation and although many theories have been advanced to explain some of the rapid changes in sedimentation, but very little actual research work has been made available. At present it appears that future prospecting in California will, of necessity, be towards testing possible stratigraphic traps and in the delineation of such prospects a comprehensive knowledge of sedimentation and environment of deposition would be of extreme benefit. In this connection Dr. Shepard of Scripps Institution of Oceanography has reported on some very interesting findings in present offshore deposits, which type of work, in my opinion, should be encouraged. A study of the effects of currents on deposition, as well as the effect of subterranean topography and active structural lines, may afford valuable information in the solution of problems involving non-uniform deposition.

Frequently the value of oil sands must be determined not only by actual production tests, but by an analysis of formation samples for porosity and permeability. Questions in this connection involve what constitutes a relationship between these two factors: degree of saturation and bottom hole pressure, which should normally indicate commercial production. Private and commercial laboratories engaged in core analysis of this type are currently employing different methods in their determinations and consequently analyses are frequently, if not always, at variance with one another. A standardization of methods and research in the relationship of the various factors should be of material benefit to those engaged in prospecting, as well as in production, and therefore it is my opinion that such research should be recommended.—F. A. MENKEN, Tide Water Associated Oil Co., San Francisco, Calif.

I have been thinking about a few specific problems which, as far as I know, to date have defied solution and which might be worthy of group study in our various provinces. This study might be undertaken in two phases—the first phase being the gathering of accurate data by regional groups of qualified men and the second being the compilation and study of this data by your research group. I refer specifically to the following questions.

1. Why does an area, such as the San Fernando Valley near Los Angeles and doubtless many other similar areas throughout the world which are closely related to large oil accumulations and which apparently contain the same competent formations

and structures as the near-by areas, remain so devoid of oil showings in the surface outcrops and in the many wells which have been drilled? This may go to the subject of time of migration, but, in the case of the San Fernando Valley, the evidence as contrasted with the evidence of the nearby Los Angeles Basin is not clear. I do not believe it can be said that the San Fernando Valley has not been adequately tested, although there will doubtless be further test drilling done, resulting from seismograph exploration.

2. We have to date been unable to explain the occurrence on our producing structures of competent sand bodies which are barren of oil. These sand bodies are in some places above, in some places below and in places bracketed by our producing sand members, and the conditions of structure and stratigraphy affecting the same seem to be identical. Does this mean that the structure has not held with respect to certain porous members or does it go to the point of extremely selective source beds and limited migration?

3. We also have the question to solve concerning a sand body or a general series of beds which prominently contain oil on one structure while on a near-by structure within the same basin, the same sand body or series is barren of oil. In the case of the latter structure, substantial oil accumulation may be found in other formations which are above or below the one which is barren. This may also go to the point of defective structure affecting one series or another, or possibly to the point of selective source beds or limited migration.

4. We also have the problem of a sand body or series which is more commonly productive in a given basin than other sand bodies or series which seem to occur under identical conditions of stratigraphy and structure.

5. It would also be interesting to explore into the realms of the varied hydrocarbon combinations which occur on seemingly similar near-by structures which variation gives rise to different gas-oil ratios and different conditions of drive and flow. We have some oils which are light, yet which seem to be almost like kerosene in being devoid of the lighter fractions and so limited in dissolved gas that the gas-oil ratios are very low even though the volume of production under water drive is very high. Such a case is the Gatchell sand (Eocene) production on the Coalinga nose. Elsewhere we find the lighter fractions retained so the reservoir and flow conditions are entirely different. In some places under the latter condition we find the light fractions evidently in solution and in some places they are apparently in the gaseous phase. Does this mean a varied source condition causing a variation in the product as originally formed or does it mean a variation in the conditions of migration and entrapment with varying amounts of fractionation and escape of the lighter products between the time for formation and the time of discovery by the drill?—FRANK A. MORGAN, Manager of exploration, Richfield Oil Corp., Los Angeles, Calif.

I feel that there is one field of investigation, that of the geochemistry of sediments, which is of first importance for work in the fields which you have suggested.

We know very little about the anamorphic and katamorphic processes which are involved in the production of sediments and in changing them after they are deposited. It seems to me that an understanding of the deposition of source beds and the generation of oil from them can only be obtained when more is known of the processes by which the molecules of hydrocarbons and carbon compounds are built up and broken down. A much better understanding of the processes bringing about changes in the inorganic constituents of sediments is also necessary, because removal and addition of material are important factors in the determination of the amount of porosity and permeability possessed by sediments; and surely permeability and porosity have much to do with the migration and accumulation of oil.

The search for oil from the beginning to the present has been a search for structures. Little attention has been given to the geological history of the region and the sedimentation, because the petroleum industry has been sold on structural conditions, but not on the others. Up to the present time no petroliferous province has been located other than by drilling where favorable structural conditions existed. This method works well as long as the structure happens to be in a petroliferous province, but I think you will agree that it is the wrong approach to the problem of finding oil, because only one factor, structure, has been considered. I feel that in future exploration much consideration must be given to source beds, reservoirs and geologic history if the present chance of success in the discovery of oil is to be maintained.—A. N. MURRAY, Department of Geology, University of Tulsa, Tulsa, Okla.

The first field to be considered is the stratigraphy in relation to the accumulation of oil. This field will probably be the hardest to find accurate data upon and is therefore one of the most fertile. It has the possibility of becoming the only reserve left in the far yet not so far distant future. It would be much to the geologist's advantage to have a fair knowledge of stratigraphic traps and their possibilities when this means is the major one left to exploitation.

The importance of structural traps and their relationship to the accumulation of oil is now one of the most important fields and so research should be continued in this field. It would be well to couple the stratigraphic and structural relationships together for the best results.

The natural order of importance in fields brings that of geophysics as the third one if the first two are accepted. This is the field that will be employed in close conjunction with geology to find the future fields. There is a very great need for better equipment and method in this field so it truly is of importance.—WILLIAM DIXON NEILER, Bellville, Tex.

The origin of oil and gas by all means! Approached through chemistry and physics, supported by a process of rigorous elimination of hypotheses, all of which should embrace the significant relationships of oil, gas and water, interpreted in the light of advanced views on sedimentation and structure and biology. This is a resounding sentence and no doubt useless!—SIDNEY PAIGE, War Department, 80 Broad St., New York.

I am pleased to make the following suggestions.

Geological research will probably be directed towards two ends (1) that of assisting in getting the greatest possible ultimate production from existing oil fields and (2) discovery of new oil fields. With reference to the first use, it is apparent that almost everything listed on the enclosed card is applicable and probably research should be encouraged in each of those classifications by those individuals best fitted to undertake them.

With reference to my second grouping, that of finding more oil fields, I believe that because of geophysical methods which will be used almost entirely (at least in California) that the principal point involved in order to discover more oil fields in a reconstruction of past geography. Unconformities are tremendously important here. Seismic surveys as now conducted give a very close picture of underground structure, as of course they would give in such Mid-Continent fields as Oklahoma City and Fitts. Any geological research which will throw a better light on the probabilities of where major inconformities may be found and the reasons therefor will automatically of course fit in with studies of sedimentation, environment of deposition and the possible migration and subsequent accumulation of oil and gas and thereby of course become involved in the origin of the oil and gas from the point of view of assuming some particular formation having been the source. In other words, I believe there is reason for intensive geological research into the realm of paleogeography to be included in your list of subjects for geological research.—J. R. PEMBERTON, oil umpire, Los Angeles, Calif.

Migration and accumulation are on the card, but it seems to me there is a particular lack of information on *speed* of accumulation. Since there has been so much criticism about leaving two-thirds, or half or some such fraction of the oil in the ground, I wonder if that is really so.

In the case of the typical oil field we have concentration of oil on top of the water in an anticline. When the field is "depleted," the volume once occupied by oil is occupied by perhaps half water and half oil. Theoretically, in sufficient time the upper half of the original oil volume will be occupied by all oil, below which is edge water. It seems to be generally believed that the time required for this re-concentration is too great to be of practical importance. I don't know, but there is some suspicious evidence that in some instances, speed of accumulation and migration is great enough to consider. If such should be the case, there may be such a thing as what I referred to the other day as the recovery of the unrecoverable oil.

It might be worth while to know the significance of production curves which follow the typical decline curve shape for a number of years, and then flatten and stay flat for up to at least 10 years with a fairly constant oil-water ratio. I have been inclined to think that in such instances the production rate is in equilibrium with the rate of migration. If it is, then the ultimate production will be nearer 100 per cent than the conventional 25–50 per cent, and something will need be done with our reserve estimates.—WILLIAM W. PORTER II, Los Angeles, Calif.

I suggest that the A.A.P.G. investigate the subject of *Distillate*. What is distillate, how and when does it occur, what is its relation to oil and gas and reservoirs, what is its economic value and what is the relation between petroleum reserves and distillate reserves?

The objection may be raised that this subject is more closely allied with petroleum engineering than with geology. It appears that it is a petroleum engineering problem in that some distillate wells, by proper completion technique, can be converted into oil wells but it is a geologic problem in that some reservoirs apparently can never be made to produce anything but distillate. The further objection may be raised to an A.A.P.G. research program into this subject on the ground that it is a problem local to the Gulf Coast, but the answer to this seems to be that when deeper drilling spreads beyond the Gulf Coast into other petroleum provinces the distillate problem will appear there.—W. G. SAVILLE, Torsion Balance Exploration Co., Houston, Tex.

It seems to me that in the past the geologists have considered their work completed when they located a structure and have let the engineers take the play away from them by studying reservoir conditions, permeability, porosity, and physical relations of oil, gas, and water. I believe that the geologists should call in capable physical chemists as the engineers have done and study the producing fields.—GEORGE SAWTELLE, Kirby Petroleum Co., Houston, Tex.

It is perhaps not easy to demonstrate just how petroleum geology would be benefited by investigation of present-day sedimentation, but this may be because there is so little known about the subject. So far as I know the symposium on recent sediments which has just been completed includes largely descriptions of the sediments on the sea floor at the present time, but is almost entirely lacking in evidence to show whether all or even a large part of these sediments were deposited under present conditions. The surprising amount of coarse sediment both at great distance from the coast and at great depths suggests that we may be dealing to a considerable extent with sediments formed under a different condition from what now exists. Large stretches of rocky bottom such as we found off the California coast add plausibility to the notion that by-passing of sediment is a common marine condition. In work carried on at the Scripps Institution we are beginning to find out about the current system which is operating at the various depths and in the various environments. However we have not made any progress to speak of in finding out about the sediment carried into the different areas under present conditions. Sediment traps used during the past year proved to be incapable of withstanding the conditions to which they were subjected so that we were only successful in recovering two which we had put out.

My proposal is that research be carried on in this field of sedimentation by constructing a variety of sediment traps and securing them by strong cable and large buoys that will withstand storms and with large enough anchors to assure their not being dragged out of positions. Traps can be designed to catch sediment migrating along the bottom or to rest flush on the bottom in such a way as to give an indication of the rate at which sediments are accumulating in different environments. Also platforms could be used to watch the development of colonies of foraminifera and other calcareous sediment producers. Almost nothing is known about these. Also the levels at which sediment migrate could be determined by suspending funnel traps at various levels above the bottom along the anchor line.

This type of research is expensive. Boats are available both on the east and west coast and possibly also on the Gulf coast so that the cost would come only in the instrument and the cable and buoys. Probably something like $2,000 will be necessary in order to carry out a project of this sort with success.—FRANCIS P. SHEPARD, University of Illinois, Urbana, Ill.

The point upon which I would like additional information is what are the reasons for, or what are the limiting factors which cause the edge of accumulation of oil to cross contours in many of the California oil fields and elsewhere. Probably one striking example of this is the Torrance oil field but there are other instances in the Los Angeles Basin, such as Montebello and West Coyote. Also why is it that the oil is in many places higher on the steep side of an anticline than the flat side? Probably these problems have as much to do with capillarity as anything.

It has always been my belief that the main research of geology is field work. The field work may, of course, be conducted from different points of view, structural,

stratigraphic, paleontologic, *etc.* Field work still is and should remain the foundation of most geologic research. Field work is particularly important for the young men who are beginning their research in geology. The National Research Council and similar bodies deal chiefly with research by young men. It cannot be emphasized often enough that field work should have precedence over any other type of research in these cases.

The various other types of research that you list in your postal card, such as origin of oil and gas and migration, require a much broader outlook on various problems of geology than is the possession of most young geologists. After a certain amount of geologic field work has been done it is possible to understand these larger problems with all the implications. Many of the problems which you have listed cannot be approached at the present time and cannot be solved. In this category fall the origin, migration, and accumulation of oil and gas.—H. B. Stenzel, University of Texas, Bureau of Economic Geology, Austin, Tex.

Fortuitously or not it appears to me that the item heading your list, i.e., "The Origin of Oil and Gas," is the primary problem confronting petroleum geologists. If we could only be sure of exactly what type of original material or materials, under what original and subsequent environments gave rise to commercial deposits of oil and gas we would have a "key horizon" from which we could progress to our theories of migration, entrapment, and recovery. Our theories (and knowledge) of all phases of the petroleum cycle, except that of origin, have progressed tremendously during the past few years. It is true that during this time there have been many noble attempts to solve the riddle of origin. Probably it is the great number of theories of origin that make most of us practicing geologists know less about this vital problem than we used to think we did.

What we and future generations of petroleum geologists need is a definite theory of origin on which the majority of us can agree. Then we can proceed with some assurance to the problems of migration, *etc.* We, of course, trust that there will always be a minority that will be skeptical enough of the theory so that eventually, when all the present available oil has been found and recovered, the future petroleum geologists will be able to instruct the future petroleum geophysicists and petroleum geo-chemists how to produce oil with the materials at hand and with the minimum expenditure of energy and time.

My suggestion is that research, and then some more research, should be done on the origin of petroleum. It would help if the problem were tackled with the idea that petroleum had originated rather frequently due to physical and chemical reactions taking place at or near the surface of the earth.—W. W. Waring, Tropical Oil Co., Colombia, S. A.

I submit herewith the following.

1. Alteration (metamorphism) of sediments as an index of conditions favoring the occurrence or absence of oil or gas.

By way of explaining what I have in mind under Item 1 there are many areas in which sediments have been subjected to such processes as would result in the development of certain metamorphic minerals. In such areas where beds of coal are present, the carbon ratio theory can be applied as an index to the probable occurrence of oil or gas. In the absence of beds of coal, however, I feel that we might find a substitute that would be fully as useful and diagnostic in the type of minerals that may have been produced in the sediments. It occurs to me that this study would have to be largely on an empirical basis and that a very good place to undertake it would be in the Appalachian region where conditions are probably best for the early work.—O. C. Wheeler, International Petroleum Co., Ltd., Toronto 2, Canada.

It seems to me that fundamentally the order in which you list the subjects is the logical order in which we would desire the information. However, progress in results is not easiest in some of the features of most importance, as can readily be judged by the results of emphasis for some time past of the question of origin, migration and accumulation. From attendance at the meetings, it seemed to me opinion was divided as to whether there was migration or lack of migration. The Research Committee at the last convention discussed the question of dropping the emphasis on origin, migration and accumulation. Personally, it seemed to me that past emphasis had started a number to thinking along such lines and that it might be better to promote

a start along other lines not quite so difficult and in which results might be more stimulating.

Of course, all petroleum geologists' first aim is in the working out of structures. As a paleontologist, I believe that, given the ability to recognize age, any structure can be solved and that paleontology, where it is available, is the most direct method of such recognition. Every specialist is inclined to emphasize his own field.

I am inclined to believe there is more room for improvement along the lines that I have heard Dr. Condra stress in his comparison of Russian and American procedure. We have stressed detail vertically, whereas the Russian has stressed horizontal detail, or, we might say, gradation.

In the areas in which I have been working of late years, I am impressed by the failure in correlation both on the surface and in subsurface, which I feel is due to improper understanding of lateral changes. While not the most important angle, it is one in which almost every one has some knowledge but in which as a whole I feel we have failed to round out our working knowledge as satisfactorily as in others.—M. P. White, Ardmore, Okla.

In answer to your request I take the opportunity to submit my opinions about the lines of research best to be followed by Petroleum Geologists.

It depends whether one has in mind the U.S.A. or the entire world as field for petroleum research. The writer has had the good fortune to see many different types of geology in northern parts of South America and in Europe, including Russia. And from a world angle of view just a few considerations may have to be marked down.

The U.S.A. petroleum geologist is seconded by tradition in this game and by a fine spirit and love for exploration over vast open areas. He is liable to loose his supremacy in his line if he specializes too much and too soon in his career.

The world over important pools are still and mainly associated with structure. Even in typical "shore line accumulations," like Maracaibo Lake fields or the Maikop fields in the northwestern Caucasus, structure plays an important part.

Stratigraphy cannot be separated from structure. Besides the pertinent features also the time of folding or of the growth of a structure wants to be established.

Foothill environments usually afford the most attractive structures. The latter frequently continue out into plains which mark a sedimentary basin.

It is probably the privilege of the petroleum geologist, that with the help of expensive geophysical research and by means of drilling carefully logged deep exploratory wells, he will learn and has to learn, more about sedimentary basins than the academic geologist.

The *study of sedimentary basins* appears to me to be one of the most promising lines of research for the A.A.P.G. The study of structure, stratigraphy and migration of oil are naturally involved.

While the large part of the members of our organization are stationed in the States, there is nevertheless a strong group which is or which has been, at some time or other, working abroad. And in the future still more petroleum geologists may be required for foreign exploration jobs. This feature, I think should not be forgotten. The study of sedimentary basins should go beyond the realm of U.S.A. petroleum geology as far as this is possible.

And, by all means, it is hoped that A.A.P.G. will stick to geology.—C. Wiedenmayer, Società Petrolifera Italiana, Fornovo Taro-Parma, Italy.

The research committee is particularly gratified over the results of this survey and of the wide variety of interest which the membership has shown in the subject of research. If you agree with any of the comments or suggestions which are published above or if the writers have touched upon something of particular interest to you, it is suggested that you contact such writers, either directly or through the research committee, and give them the benefit of your ideas on the subject. In this way it is hoped that sufficiently strong bodies of opinion might be developed in various directions so as to justify the research committee in taking some action along the suggested fields of research.

It is realized that the subjects listed on the cards are of a general nature

and that they overlap to some extent. It is planned to submit those subjects which are of most interest to our members to special workers in these particular fields and ask that specific problems for research be suggested. These special problems within the general field will then be distributed to universities and research organizations with the hope that they will be of interest and use to prospective research workers who may be looking for problems within the field of petroleum geology.

In addition to satisfying the curiosity of the research committee as to the relative interest of our membership in the various fields of research, the survey has several other possible uses. Thus, it furnishes a basis for special emphasis in teaching and college curricula; a person entering the field of petroleum geology might well consider adapting his interests to those subjects which the survey indicates are of most importance; research workers looking for problems in petroleum geology might well use the results as a guide to the general fields of research which are relatively of most interest to the majority of petroleum geologists; and the results of this survey should furnish a sound basis for the development of various symposia and the publication of articles or even a special volume describing oil fields, with special emphasis, for example, on the related factors of sedimentation, reservoir conditions, and stratigraphy.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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Memorial

JOHN YOUNG SNYDER

(1872–1939)

The death of John Young Snyder, Tuesday, January 10, 1939, removed from the ranks of the American Association of Petroleum Geologists, one of its past-presidents, and one of its most outstanding members.

He is survived by his wife, Mrs. Hattie O'Kelly Snyder, two sons, J. Y. Snyder, Jr., of Baton Rouge, Louisiana, Millard Purnell Snyder, a student at Tulane University, one daughter, Mrs. Elizabeth Lohman of Chicago, and a brother, W. M. Snyder of Winnsboro, Louisiana.

Mr. Snyder was born on Cuba Plantation near Winnsboro, Louisiana, January 30, 1872. His father was Caleb H. Snyder who came from Pennsylvania and settled near Winnsboro, and his mother was Jane Cordill Snyder, a native of Tensas Parish, Louisiana.

Mr. Snyder received his educational training at Jefferson Military Academy near Natchez, Mississippi; Vanderbilt University, where he specialized in geology; and he graduated at Tulane University receiving an M.S. degree, majoring in engineering and architecture.

As a student in Tulane he became interested in the then very vital problem of how to keep seepage water out of New Orleans, especially when the water in the river, held back by the levee, would be several feet higher than the level of the streets in the city. The enormous hydraulic pumps now in use by the City of New Orleans are the product of his ingenuity.

Mr. Snyder moved to Shreveport in 1899 and for a number of years devoted his time to engineering and architectural work and his success and accomplishments in those fields would have satisfied one of lesser ambition.

When the first oil was discovered in the Shreveport district, Mr. Snyder became intensely interested in it, and from that time to the day he became incapacitated for work, 5 years ago, he was one of the outstanding figures in the development of northwestern Louisiana as an oil-producing district. He was the first to see the necessity of accurately kept logs and elevations of wells and he made the first contour map of the Shreveport district. He had faith in the oil possibilities of northern Louisiana, and he never ventured far from his native state in his personal investments.

As an independent geologist he gave information freely to drillers and operators alike, and, in return, he secured many confidential cores and logs of wells, information which was later used in working out subsurface conditions of northern Louisiana. During the early years of his geological activities his office was a clearing house of free information.

A man's life is judged by its results. With his well trained mind Mr. Snyder never wrote a scientific treatise, and he left behind very few subsurface contour maps, yet in the discovery of the following oil and gas fields of Louisiana he left a record that few geologists will ever attain. It is the discovery of Elm Grove, Haynesville, Bellevue, Homer, Sugar Creek, Sligo, and

JOHN YOUNG SNYDER

White Sulphur Springs of northern Louisiana, and the Lirette gas field of Terrebonne Parish of southern Louisiana, that brought the name of John Snyder before the oil and geological fraternities.

When he had sufficient information to outline a prospective field he called in a group of his associates who had faith in his geological ability, and his commercial success in Homer, Haynesville, Bellevue, Sligo, and other fields is well known to his friends and associates.

Mr. Snyder is credited with being the first one to make and put into use a core barrel with teeth cut on the end of ordinary 3- or 4-inch pipe. At least, he was the first one to use it in the Shreveport district. He is also the first to suggest and supervise the use of cement in setting casing in wells.

Mr. Snyder numbered his friends from every walk of life. He loved the fellowship of his friends, and for 4 or 5 years previous to his physical breakdown he kept his office open chiefly for association. He befriended many worthy young men with financial aid and after graduation assisted them in getting their first jobs. His advice and counsel were sought by men in many walks of life. His droll humor and rich storehouse of information on almost any subject of conversation drew men to him and made him a most charming companion and friend, and his passing is our distinct loss.

In the *History of Shreveport and Shreveport Builders* by Lilla McLure and J. Ed Howe, published in 1937, the following introductory paragraph on the life and accomplishments of John Young Snyder shows the high esteem in which he is held by the people of Shreveport: "No citizen of Shreveport has contributed more toward its growth and development and the growth and development of the territory surrounding the city than John Young Snyder, engineer, architect, and geologist."

A. F. Crider

Shreveport, Louisiana
February 8, 1939

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23 NO. 3 (MARCH, 1939). PP 457-460

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

KENNETH DALE OWEN spoke before the Shreveport Geological Society, on February 3, the subject being "Correlations of Surface and Subsurface in Two Typical Gulf Coastal Areas."

IRA H. CRAM, secretary-treasurer of the A.A.P.G., addressed the Oklahoma Oil Scouts Association at Enid, last month.

H. E. REDMON, of Wichita, Kansas, who has been with the National Refining Company for 9 years, was promoted, February 1, to the position of superintendent of exploration in the area west of the Mississippi River. This department includes the divisions of land and lease, geological, geophysical, scouting, and consulting production engineering.

DON B. GOULD discussed the "Geologic History of the Southern Part of the Front Range," at the regular meeting of the Rocky Mountain Association of Petroleum Geologists, at Denver, Colorado, February 6.

JOHN G. BARTRAM, division geologist of the Stanolind Oil and Gas Company, Tulsa, Oklahoma, reviewed "Rocky Mountain Geology," before the Tulsa Geological Society, February 6.

H. M. HORTON, chief geologist of the Superior Oil Company, Houston, Texas, and a director of the company, has resigned and is specializing independently in geology, geophysics, and land work.

CHARLES E. CLOWE, Ardmore, Oklahoma, is executive manager of the new Stripper Well Association of Oklahoma.

H. C. ARNOLD, in charge of land and geological work of the British American Oil Producing Company, Tulsa, has been elected a vice-president of the company.

MALVIN G. HOFFMAN, chief geologist of the Midco Oil Corporation, Tulsa, addressed the Mid-Continent Royalty Owners Association on the subject of chemical analysis of soil in exploration work, February 7, at the Mayo Hotel, Tulsa.

G. R. SPARENBERG, formerly at Owensboro, Kentucky, may be addressed at 1802 Nueces Street, Austin, Texas.

O. L. BRACE, consulting geologist of Houston, Texas, was in New York during February, attending a conference in relation to the Greek oil concessions of Wm. Helis. Brace is directing the geological investigations that are now in progress in Greece.

GEORGE H. GIRTY, geologist and paleontologist of the U. S. Geological Survey who specialized on Carboniferous formations, died on January 27 at the age of 69 years.

Fred W. Bates, geologist with the Continental Oil Company at Lafayette, Louisiana, has resigned that position to engage in consulting geologic and micropaleontologic work in the Gulf Coast of Louisiana.

Ian Campbell and John H. Maxson, of the California Institute of Technology, are the authors of "Geological Studies of the Archean Rocks at Grand Canyon, Arizona," published in the Carnegie Institution of Washington Year Book No. 37 (1938), pp. 359–64.

Norman H. Donald, Jr., talked on "The Geology of the Golden Area," at the February 20 meeting of the Rocky Mountain Association of Petroleum Geologists at Denver, Colorado.

M. G. Hoffman, chief geologist of the Midco Oil Corporation, spoke before the Tulsa Geological Society, February 20, at the University of Tulsa, on the subject, "Rôle of Isostasy in Mountain Building."

N. W. Bass, of the United States Geological Survey, Tulsa, and H. M. Smith, of the United States Bureau of Mines, Bartlesville, Oklahoma, presented their paper on the "Relationship of Oils in Mississippian Limestone and Shoestring Sands of the Cherokee Shale in Osage County, Oklahoma, and a part of Southeastern Kansas," before the Tulsa Geological Society, February 20.

The officers of the Ardmore Geological Society, Ardmore, Oklahoma, are: president, Don L. Hyatt, district geologist for the Carter Oil Company; vice-president, J. P. Gill, district geologist for the Sinclair Prairie Oil Company; and secretary-treasurer, W. Morris Guthrey, district geologist for The Texas Company.

The officers of the Shawnee Geological Society, Shawnee, Oklahoma, are: president, Roy P. Lehman; vice-president, J. Lawrence Muir; secretary-treasurer, Tom L. Girdler, Jr.

The Western Kentucky Geological Society, Owensboro, Kentucky, has elected the following officers for 1939: president, N. W. Shiarella; vice-president, George R. Wesley; secretary-treasurer, Ralph E. Knipe.

The Illinois Geological Society presented the following program at the U. S. Grant Hotel, Mattoon, Illinois, February 17: "Geology of the Basin Fields of Southeastern Illinois," by Lynn K. Lee of the Pure Oil Company, and "Mississippian Border of the Eastern Interior Basin," by J. Marvin Weller of the Illinois State Geological Survey.

Robert M. Kleinpell, consulting micropaleontologist with laboratories at Bakersfield, California, is devoting part of his time to instruction in micropaleontology in the Division of the Geological Sciences at the California Institute of Technology at Pasadena.

W. M. Plaster is employed by Wm. M. Barret, Inc., consulting geophysicists, Shreveport, Louisiana.

The Southwestern Geological Society at Austin, Texas, has elected the following officers: president, Duncan McConnell, University of Texas; vice-president, Leo Hendricks, Bureau of Economic Geology, Austin;

secretary-treasurer, W. C. IKINS, University of Texas. Meetings will be held on every third Friday at 8:00 P.M. at the University of Texas, Geology Building 14.

The North Texas Geological Society, Wichita Falls, Texas, recently elected the following officers: president, TOM F. PETTY, Humble Oil and Refining Company; vice-president, PAUL E. M. PURCELL, 701 Hamilton Building; secretary-treasurer, ORION A. DANIEL, 814 Hamilton Building.

K. WASHINGTON GRAY, formerly with the Anglo-Iranian Oil Company, Ltd., London, is now chief geologist of the Australasian Petroleum Company Pty. Ltd., Port Moresby, Papua.

OTTO GUTZWILLER, of Bremgarten, Aargau, Switzerland, is engaged in exploration in Peru for several months.

CHESTER K. WENTWORTH is the author of "Ash Formations of the Island of Hawaii," the recently published third special report of the Hawaiian Volcano Observatory, of which T. A. JAGGAR is director.

JOHN CLARK spoke on "Eocene Streams and Mountains of Northeastern Utah," before the Rocky Mountain Association of Petroleum Geologists, at Denver, Colorado, March 6.

The officers of the Alberta Society of Petroleum Geologists, Calgary, Alberta are: president, JOSEPH S. IRWIN, consultant, 812 Lancaster Building; vice-president, VERNON TAYLOR, Black Diamond, Alberta; secretary-treasurer, J. OWER; business manager, B. L. THORNE, Canadian Pacific Railway Company, National Resources Department, Calgary, Alberta.

JOHN L. RICH, associate professor of geology at the University of Cincinnati, is spending several months with his wife and daughter, touring South America by air, gathering first hand evidence on structure and tectonics, and visiting mining districts in Chile, Bolivia, and Peru.

N. H. DARTON, since his retirement from the U. S. Geological Survey, has continued field work on the structure of part of the Atlantic Coastal Plain on grants from the Penrose fund of the Geological Society of America. Reports on sand and gravel of Maryland and structure of the northern anthracite basin are being published by the Survey and a geologic and topographic map of South Dakota is in preparation. Considerable expert work has been done on foundations and dam sites and studies have been made of certain problems connected with potash mining in New Mexico.

The South Louisiana Geological Society, Lakes Charles, Louisiana, presented the following program, February 21: "The Sparta-Wilcox Trend," by JOHN D. TODD of the consulting firm of Roper and Todd, Houston, Texas, and "The Origin of the Cap Rock of Louisiana Salt Domes," by RALPH E. TAYLOR of the Freeport Sulphur Company.

OLAF P. JENKINS, chief geologist of the State Division of Mines, San Francisco, lectured before the California Academy of Sciences at Golden Gate Park, San Francisco, on "Salient Events in the Geological History of California."

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

(Continued from page 357)

FOR ACTIVE MEMBERSHIP

George Howard Burress, Oklahoma City, Okla.
Irving Perrine, Albert S. Clinkscales, Hubert E. Bale
Joseph Hayes Girdler, Mattoon, Ill.
T. E. Weirich, J. K. Knox, D. E. Lounsbery
Leo Ray Newfarmer, Houston, Tex.
Roy R. Morse, W. Dow Hamm, Paul B. Hunter

FOR ASSOCIATE MEMBERSHIP

Stewart Barclay, Bartlesville, Okla.
William Henry Courtier, D. E. Lounsbery, Hugh W. O'Keeffe
William George Blackwell, Golden, Colo.
W. A. Waldschmidt, Dart Wantland, F. M. Van Tuyl
Robert Ranney Harbison, Wichita, Kan.
Howard S. Bryant, Phil K. Cochran, Edward A. Koester
Clifford Garland Hardin, Hazard, Ky.
E. E. Brossard, P. E. Nolan, Hollis D. Hedberg
Manley Osgood, Jr., Saginaw, Mich.
Kurt H. de Cousser, Virgil R. D. Kirkham, Raymond S. Hunt

FOR TRANSFER TO ACTIVE MEMBERSHIP

Dan D. Heninger, Wichita Falls, Tex.
Frank R. Clark, Ira Otho Brown, A. K. Tyson
James Cecil Nelson, San Antonio, Tex.
Joseph M. Dawson, Willis Storm, R. F. Schoolfield
Edwin F. Ustynik, El Dorado, Ark.
Roy T. Hazzard, W. B. Weeks, A. F. Crider
Ralph E. Warner, Abilene, Tex.
M. G. Cheney, K. B. Nowels, Riley G. Maxwell
Arthur A. Wedel, Tulsa, Okla.
R. A. Liddle, F. E. Poulsen, C. M. Nevin

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DENVER, COLORADO

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985 Gilbert Street, Boulder
1st Vice-President - - - David B. Miller
1336 Gaylord Street
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810 U. S. National Bank Building
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224 U. S. Customs Building

Dinner meetings, first and third Mondays of each month, 6:15 P.M., Auditorium Hotel.

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Vice-President - - - - Thomas H. Allan
Consulting Geologist
Secretary-Treasurer - - - - E. Gail Carpenter
Consulting Geologist
Manager of Well Log Bureau - Harvel E. White

Regular Meetings: 7:30 P.M., Allis Hotel, first Tuesday of each month. Visitors cordially welcomed.

The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

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THE SHREVEPORT GEOLOGICAL SOCIETY
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Grogan Oil Company
Secretary-Treasurer - - - - - - - E. F. Miller
Bay Oil Corporation, 911 Commercial Bank

Meets the first Friday of every month, 7:30 P.M., Civil Courts Room, Caddo Parish Court House. Special dinner meetings by announcement.

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Secretary - - - - - - - G. O. Grigsby
Stanolind Oil and Gas Company
Treasurer - - - - - - - Baker Hoskins
Shell Petroleum Corporation

Meetings: Luncheon 1st Wednesday at Noon (12:00) and business meeting third Tuesday of each month at 7.00 P.M. at the Majestic Hotel. Visiting geologists are welcome.

MICHIGAN

MICHIGAN GEOLOGICAL SOCIETY

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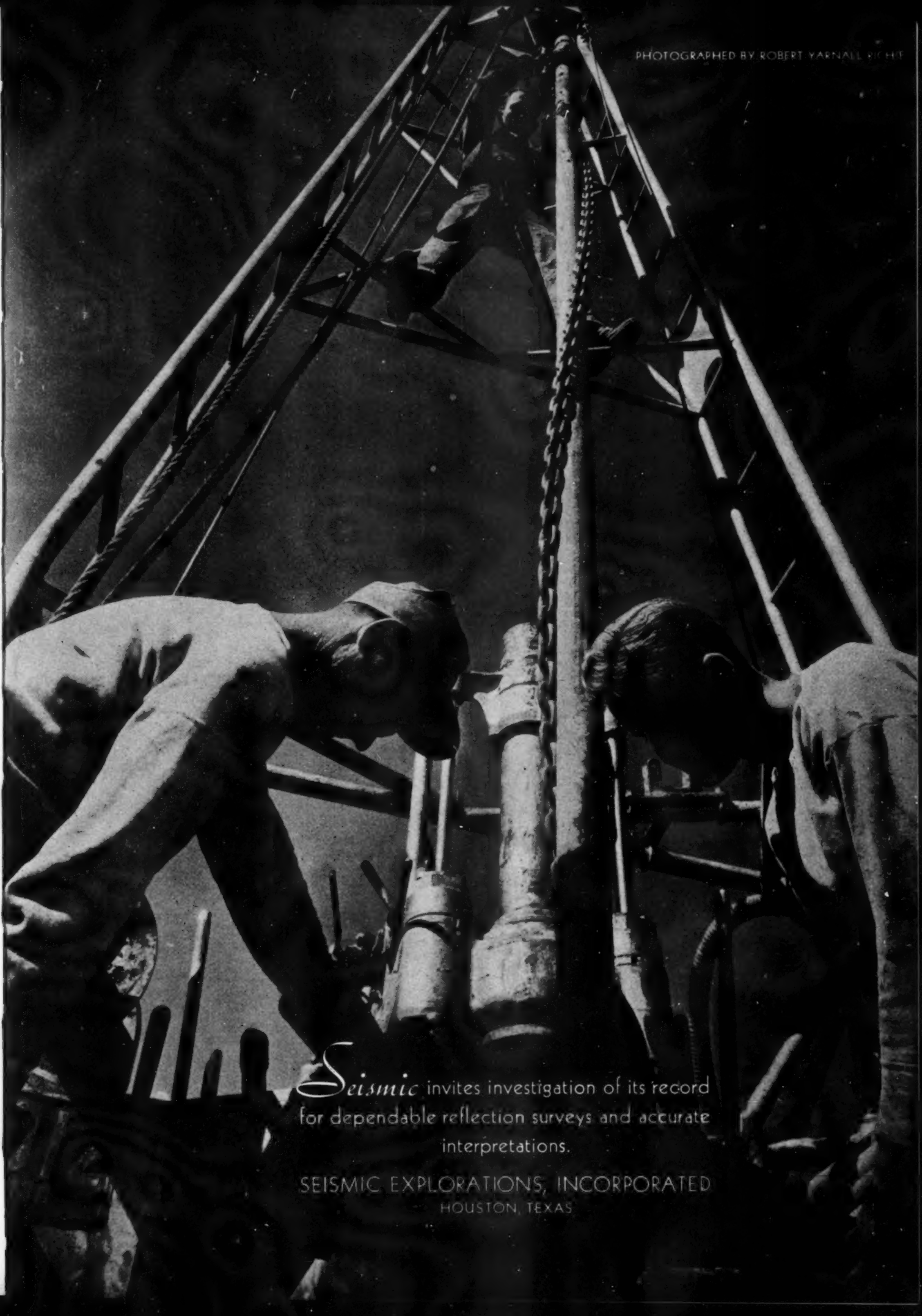
Vice-President - - - - - - Jed B. Maebius
Gulf Oil Corporation, Saginaw
Secretary-Treasurer - - - - - R. P. Grant
Michigan Geological Survey, Lansing
Business Manager - - - - Helen Martin
Michigan Geological Survey

Meetings: Monthly dinner meetings rotating between Saginaw, Mt. Pleasant, and Lansing. Informal dress.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